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THE

ANATOMY AND PHYSIOLOGY

OF THE

NERVOUS SYSTEM.

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IN TWO VOLUMES.

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TO

RICHARD CARMICHAEL, ESQ. M.R.I.A.

One of the senior Surgeons of the Richmond Hospital.

MY DEAR SIR,

If you were a private character, I should be unwilling to address you in the language of praise, lest, considering the friendly feeling you have always evinced towards me, it should be thought to proceed rather from my gratitude than my judgment; but I shall not fear to incur this censure in expressing my respect for an individual whose talents have placed him at the head of his Profession in this country, and whose

writings have obtained for him the highest character in every other. I feel considerable gratification in being permitted to place so distinguished a name at the head of this Work, and assure you, that no event can give me greater pride or satisfaction than I feel in having been the Pupil, and acquired the friendship of Richard Carmichael.

Believe me, my dear Sir,
With great respect,
Your obedient servant,

VALENTINE FLOOD.

19, *Blessington-street,*
Dublin.

PREFACE.

My original intention in the composition of this Work was to describe minutely the different parts of the Brain, Orbit, and Spinal Marrow, in the order in which they presented themselves in dissection, and to make this, the first volume, of a System of Relative Anatomy on the same plan. But as I proceeded in the work, and convinced myself of the length of time it would require to accomplish such an undertaking, I

thought it would be more adviseable in the first instance to complete an Anatomy of the Nervous System, and reserve the materials of the former for a future occasion. This will account for the description of arteries, glands, bones, and other adjacent parts found in the work, though not included in its title. At the time the Anatomical part of this first volume was printed, it was not my intention to add *the Physiology* of the Nervous System, which was composed—each sheet after the preceding was printed. I trust this circumstance will be a sufficient apology for any omission or want of arrangement that may be found in this portion of the work.

The second volume will contain the minute Anatomy of the Orbit and its contents, the Eyelids, Lacrymal Apparatus, and all the Nerves of the body, and will be very shortly published.

ANATOMY

OF

THE BRAIN.

In order to expose the Brain for the purpose of dissection, the subject should be placed on its anterior surface, the Hair cut close to the integuments, and an incision made down to the bone, passing over the vertex and extending from Ear to Ear. If it is your wish to examine the nerves of the Scalp afterwards, you will divide fewer of them by an incision on the middle line from before backwards. After making the transverse incision you next invert the Scalp by drawing it over the Face and back of the Neck, and then detaching the Temporal Muscle and its aponeurosis, you expose a sufficient portion of the bone.

This should be divided with a saw if you intend to preserve the Cranium, or to examine Bichat's Canal; otherwise the thin edge of a hammer may be employed to break it in a circular direction. The latter method is more expeditious, and will do less injury to the membranes of the Brain.

The most common errors committed in dividing the Cranium are, sawing too low down in front, and not sufficiently low behind, or giving the saw such a direction, that instead of a circular, it describes a spiral line, the extremities of which consequently do not meet. These errors may be avoided by previously marking the bone in the proper direction. The best place to commence sawing is where the Cranium is weakest, viz. at the squamous portion of the Temporal Bone. Considerable force will often be necessary to detach the roof of the Cranium from the Dura Mater, to which it adheres at all periods, but particularly during infancy, and in the old subject. You are to overcome the adhesion with the handle of your scalpel or with your finger. If this

cannot be effected you must saw it in different places and cut the Dura Mater round the fragments. The Head is now to be raised and the Chin supported on a block, so as to have the base of the Cranium in nearly a horizontal position.

The external surface of the Dura Mater thus exposed, will present a rough flocculent appearance, and in the young subject numerous dots of blood, owing to the rupture of a number of vessels that connected it to the interior of the Cranium. From its surface are detached a number of fibrous filaments, which are very numerous in the situation of the Sagittal Suture, and serve to connect the Dura Mater to the Pericranium. The tortuous veins of the Brain, particularly if distended with blood, may be seen through the semi-transparent membrane, giving it a mottled appearance, somewhat resembling marble. We may also observe, on the middle line from before backwards, a number of small cerebral protuberances that are received into corresponding pits or depressions in the Cranium, and are situated in the course

of a canal for the venous blood of the Brain, termed the *Superior Longitudinal Sinus.*

This Sinus may be laid open by dividing the Dura Mater with the scissars on the middle line from behind forward. It is small in front where it commences at the Crista Galli, by a Cul de Sac, or by a small vein ascending through the foramen (in such case improperly) termed Cæcum. As it passes backwards it becomes much more capacious, and terminates in the Torcular Hierophili opposite the internal Occipital Protuberance. According to Boyer and many other anatomists, the fibrous layer of the Dura Mater consists of two laminæ, the external of which forms the Cranial Periosteum and fibrous sheaths of the nerves; the internal forms the different processes, such as the Tentorium Falx, &c., and both contribute to form the sinuses. According to this view, the Superior Longitudinal Sinus is formed by the internal layer of the Dura Mater of one side, approaching the internal layer of the opposite side; and both descending between the hemispheres of the

Brain, to constitute the Falx. Before they meet, however, they form the sides of the Sinus, and its roof is formed by the external layer, continued without interruption across the Sagittal Suture; from this account it follows, that a transverse section of the canal will present a triangular form with the Apex turned downwards. Its angles are rounded off interiorly by the lining membrane, which is a continuation of the lining membrane of the Jugular, and other veins with which it communicates.

A number of fibrous bands may be observed stretching transversely across the Sinus. These are usually called *Chordæ Willisii;* they are invested by the lining membrane, and their supposed use is to prevent over distention of this canal.

On the interior, as well as the exterior of the Sinus we observe the small cerebral protuberances already spoken of. It is to the internal sett the term *Glandulæ Pacchioni* should be restricted. They are considered as morbid appearances by some anatomists, but they are too frequently met with to justify this

supposition. They appear to project into the Sinus, but are covered by its lining membrane. Diemorbroeck supposed they were of the same nature as the glands, which, according to Malphigi, composed the cortical substance of the Brain. Pacchioni himself supposed, that the Dura Mater was a muscular membrane, that the fibrous bands observed in the Sinus were its tendons, and that these bodies had ducts opening on the Pia Mater that supplied a lubricating fluid for facilitating the motions of the Dura Mater. They may be found either separate or in groups—they are chiefly around the orifices of the veins, and under the Chordæ Willisii: there are some of them in the Torcular Hierophili, and about the mouths of the veins in the adjacent parts of the lateral Sinuses—also in the Straight Sinus at the mouths of the Venæ Magnæ Galeni.

The Superior Longitudinal Sinus receives veins from the exterior of the Head by the parietal foramina, from the diploe of the Skull, and from the Dura Mater; here also empty themselves the veins

from the internal and convex surfaces of the hemispheres. The greater number of the latter (but not all) enter at acute angles from behind forwards, to obviate the ill effects regurgitation of blood would have on the substance of the Brain; and the blood flows through the Sinus in the opposite direction. Mr. Bell supposes the Glandulæ Pacchioni perform the office of valves to the mouths of these vessels.

Those veins that traverse the Cranium and connect the external veins to the Sinuses within, were particularly described by Santorini, and are therefore called *the Emissary Veins of Santorini:* to this class belong the Parietal Veins just mentioned, as well as the Mastoid and others to be noticed hereafter.

The Greater Falx may now be exposed by incisions through the Dura Mater, corresponding to the incision of the bone; this should be done with a scissars, one blade of which should have a blunt extremity. The Dura Mater is now to be removed from the upper surface of the Brain, by drawing it towards the middle line, where it will be found very adherent,

partly on account of the veins that enter at this part into the Longitudinal Sinus, and partly owing to a range of minute granular bodies in the Pia Mater; these have a fatty appearance, but their exact nature is not understood. On destroying these adhesions the Falx will be fully exposed.

It is a falciform process, as its name implies, of the Dura Mater. It has an Apex embracing the Crista Galli, a base corresponding to the Straight Sinus, a superior margin convex corresponding to the Frontal and Sagittal Satures and middle line of the Occipital Bone, and containing the Superior Longitudinal Sinus; and lastly, an inferior margin concave, containing, in its two posterior thirds, the Inferior Longitudinal Sinus, and corresponding closely to the Corpus Callosum behind. In front it is at some distance from this Commissure, as the Falx only fills an anterior third of the fissure between the anterior lobes of the Brain; in the two posterior thirds vessels pass from one hemisphere to the other. The sides of the Falx correspond to the

sides of the hemispheres of the Brain. The use of this process is to separate and support the hemispheres in lying down, so as to prevent one from pressing on the other, and to give sufficient tension to the tentorium which supports the posterior lobes of the Brain. We occasionnally find it perforated so as sometimes to allow the hemispheres of opposite sides to adhere together.

Let us now detach the apex of the Falx from the Crista Galli and throw this process backwards, and observe the smooth and glistening appearance of the interior of the Dura Mater; this is owing to the Serous Layer, or Arachnoid Membrane, that lines it, and which is a perfectly distinct membrane from the Dura Mater; but when the latter is said to be a Fibro-serous Membrane the Arachnoid is always included. The same glistening appearance may be observed on the surface of the Brain, owing to the same cause.

The fissure, from which we have removed the Falx is termed the *Great Longitudinal Fissure;* it

separates the Brain into two hemispheres and descends in front entirely down to the base of the Cranium; behind this, to the Corpus Callosum, and posteriorly to a transverse septum of Dura Mater, termed the Tentorium.

Each *Hemisphere* resembles, in shape, the quarter of an ovoid cut longitudinally: it has three surfaces, an inferior one irregular, corresponding to the tentorium and base of the Cranium, an internal plane and vertical, corresponding to the Falx, and a convex surface looking upwards and outwards.

The convex surfaces of the hemispheres are remarkable for a number of tortuous eminences, named Convolutions, from their resemblance to those of the intestines. The Convolutions of the right and left hemispheres are seldom exactly alike; they are badly marked in the fœtus and young child, and they vary in size in persons of the same age. Sometimes a Convolution is single, at other times it presents on the surface a bifurcated appearance; and in some situations you observe the superior margin

of a Convolution sinking below the surface and re-appearing at another part. The Arachnoid Membrane passes over the Sulci from one Convolution to another, while the Pia Mater, which is between the Arachnoid and the Brain dips down into the Sulci, separating the Convolutions and carrying in blood-vessels: these Sulci are also called *Anfractuosities*. The veins that we find on the surface are generally placed over the Anfractuosities; however, you may see many veins crossing over the Convolutions.

We may now slice off something more than an inch in depth of the upper part of the hemispheres; this will exhibit the manner in which the Convolutions are formed. Each Convolution consists of two medullary laminæ juxta-posed at their insides, and covered on their outsides by the cortical layers that bound the Anfractuosities. We occasionally find these medullary laminæ separated; as by the fluid of hydrocephalus, so as to *unfold* the Convolutions and obliterate the Anfractuosities. In such case the appearance of the Brain will be that of a large bag

distended with fluid, of a grey colour externally, and without any appearance of Convolutions. Gall and Spurzheim point out several ways in which this lamellated structure of the Convolutions may be seen, as by boiling them in oil, by injecting air or water on the middle line of the section of a Convolution, or by hardening them in alcohol, or in dilute nitric, or muriatic acids.

Each of the Sulci is bounded by the Cortical Substance; contains Pia Mater and vessels, and is closed above by Arachnoid Membrane.

If we separate the hemispheres and look down into the great Longitudinal Fissure we will see, first, the Arachnoid reflected from one side to the other; this being ruptured and the Pia Mater removed, we bring into view the Corpus Callosum, on the middle line of which, from before backwards, is a ridge, termed the *Raphe,* and each side of the Raphe is a Sulcus separating it from another ridge which is not parallel to the Raphe, but converging in front towards its fellow sometimes forms a single line.

These last ridges, or filaments, have been considered as nerves by some anatomists; they are generally tortuous in their course; Winslowe called them Petits Cordons, and Vic d'Azir called them *Longitudinal Medullary Tracks.* The Sulci, between them and the Raphe, lodge the arteries of the Corpus Callosum, or *anterior arteries of the Brain.*

These arteries arise one on each side from the internal carotid at the base of the Brain; they then run forwards converging, and communicate by one or more transverse branches; after this, they ascend through the anterior part of the great Longitudinal Fissure, and then take a direction backwards along the upper surface of the Corpus Callosum to its posterior extremity: in this course they nearly circumscribe this Commissure. From their concavities they give branches to the Corpus Callosum, and from their convexities they give more considerable branches to the internal surfaces of the hemispheres; these enter the Anfractuosities and subdivide; many of them penetrate to the convex surfaces of the hemis-

pheres, where they anastomose with the branches of the posterior and middle cerebral Arteries. The relations of these Arteries, in the first part of their course, will be explained when we come to the base of the Brain.

External to each Longitudinal Medullary Track is a smooth surface, which supports the inferior and internal part of the hemisphere, with which it forms a kind of narrow Sinus, taking a longitudinal direction; these Sinuses, one on each side, have been compared to the Sinuses of the Larynx; they have a much greater resemblance to the Sinuses between the bodies of the Testes and Epididymi.

The Longitudinal Medullary Tracks are crossed at right angles by other filaments which pass beneath them, and are termed *Transverse Medullary Tracks.* According to Boyer, these pass without interruption from one hemisphere to the other: Cloquet represents them as reaching the Raphe, and then inflected towards the lateral ventricles; they are more salient and remakable at the posterior part of the Corpus Callosum than at the anterior.

We may now slice off, horizontally, the upper parts of the hemispheres about midway between the Corpus Callosum and their superior surfaces. In this way we expose, on each hemisphere, a lesser Centrum Ovale, or *Centrum Ovale of Vic d'Azir.* It is an oval surface of medullary matter circumscribed by a cortical waving border. These are not to be confounded with the great *Centrum Ovale of Vieussens,* which is single, occupies the whole surface of the Brain, and is exposed by cutting off both hemispheres on a level with the Corpus Callosum. The cortical border of this dips in towards the centre at its posterior part following the fissure; the medullary portion consists of the Corpus Callosum on the middle line, and the substance of the hemispheres at either side.

The Corpus Callosum presents two extremities, two surfaces, and two sides. It is placed nearer to the anterior than the posterior extremity of the hemispheres, and is much broader and thicker behind than in front. On its superior surface we have described

the Raphe, Sulci for its vessels, medullary tracks, and smooth surface externally contributing to form a Sinus; it corresponds on the middle line to the Falx, with the interposition of Arachnoid Membrane and Pia Mater; more externally to the anterior arteries of the Brain, and still more externally it supports the internal and inferior portions of the hemispheres. Finally, it is convex from before backwards, and nearly plane from side to side. It appears quadrilateral as viewed on its upper surface; but it is really triangular, for the Apex, at its anterior extremity, is turned downwards, and then reflected backwards, forming part of the floor of the lateral Ventricles, while the rest of the Corpus Callosum forms their roof.

The anterior extremity is concave from side to side, and convex from above downwards; it is at some distance from the Falx, but is embraced by the anterior arteries of the Brain. The posterior extremity also reflected, passes forwards under the quadrilateral portion and divides into two cornua,

which, uniting with the Cornua, or posterior pillars of the Fornix, form the white substance of the Hippocampus major. This extremity is broader than the anterior, but like the latter it is convex from above downwards, and concave from side to side; it corresponds on the middle line to the Falx, and is embraced by the terminations of the anterior arteries of the Brain.

The inferior surface of the Corpus Callosum is concave and broader than the superior. Its relations will be enumerated after the Ventricles are laid open. It was formerly supposed to be a great Commissure in which the converging fibres of the Cerebrum terminate.

Gall and Spurzheim consider the substance of the Brain as consisting of two parts distinct from each other in their nature. One of these they term the *Pulpy Substance*, which is generally (though not essentially) of a grey colour, and includes what other anatomists have termed the Cortical and Cineritious Substances. The second kind of matter they term

the *Fibrous Substance;* it is the same that we are in the habit of calling the Medullary Matter. That the medullary substance is of a fibrous nature, is an opinion which Dr. Gordon has traced as far back as Malpighi, who compared its fibres to the pipes of a church organ. Gall and Spurzheim suppose the pulpy substance to be the matrix of the fibrous matter, and to have the same use (viz. to afford an origin to the white fibres) whether found on the exterior or interior of the Brain. They do not mean, however, to assert, as they are represented by Bostock and Majendie, that it *secretes* the fibrous matter, but merely that it necessarily precedes the formation of the latter, as cartilage does that of bone.—*See Spurzheim's Physiognomonical Work,* 1815, *and his Work on the Brain,* 1826.

The fibrous substance they suppose to consist of two sets of filaments, viz. converging and diverging. *The converging filaments* arise from the cortical substance investing the Brain and Cerebellum, and terminate on the middle line in commissures, such as the Corpus Callosum, Pons Varoli, &c.

The diverging filaments come principally from the Medulla Oblongata, and ascend in a radiated manner to terminate in the internal part of the Cortical Layer, which they consequently render of a lighter colour than the external. In this course they pass through masses of grey matter (Corpus Striatum, Dentatum, Optic Thalamus, &c.) which are termed Ganglions, and which are distributed in the cerebral mass for the purpose of reinforcing the diverging fibres with additional filaments. The two setts of filaments may be seen decussating at the bottom of each Convolution : by the bottom of a Convolution is meant the part nearest the Ventricle.

We may now slice off, horizontally, portions of the Medullary Matter a little external to the Raphe, till we come down on the lateral Ventricles; when they are once opened at any part we should use the handle of a scalpel wetted, to expose the remainder of them, following carefully the direction of the cavities themselves. When this is done at both sides, we will have exposed the Anterior Cornua, Bodies, and

posterior Cornua of the lateral Ventricles, which, together with the inferior Cornua that cannot yet be seen, make up the whole of these cavities. The most remarkable eminences in each of the lateral Ventricles are:—in front a brown pear-shaped eminence, termed the Corpus Striatum; behind this a white pear-shaped eminence, termed the Optic Thalamus; and in the groove between these a greyish band, termed the Tænia Semicircularis Geminum. A reddish membrane may be seen separating the Thalamus from a horizontal triangular lamina, termed the *Fornix*. You have now an opportunity of observing the relations of the inferior surface of the Corpus Callosum, or the parts on which it rests; they are as follows:—first, on the middle line it rests on the Septum Lucidum; at either side of this on the Fornix and Plexus Choroides; still more externally it corresponds from before backwards to the Corpus Striatum, Tænia Semicircularis, and Optic Thalamus; and behind the Fornix it rests on the Velum Interpositum.

The Anterior Cornua of the lateral Ventricles commence in front at the distance of nearly two inches from the anterior extremities of the hemispheres, and about one inch distant from each other; from these points they may be traced ascending slightly towards each other, and describing each of them a curvature of which the convexity looks forwards and inwards, and terminating posteriorly in the bodies. *The bodies of the Ventricles* are parallel to each other; and each of them bifurcates at its posterior extremity into an inferior and posteror Cornu; the latter may be traced descending slightly into the posterior lobes of the Brain, forming on each side a curvature, of which the convexity looks outwards; the former winds round the Optic Thalamus and descends to the base of the Brain, where it terminates behind the fissure of Sylvius, at a point inferior and external to the commencement of the anterior Cornu.

Let us now examine these parts particularly, and first the *Septum Lucidum;* this may be seen by raising the central portion of the Corpus Callosum

very gently, with the handles of two knives placed one at either side; or it may be seen by making a transverse incision vertically through the Corpus Callosum and Septum. It is a vertical medullary partition between the two Ventricles, triangular, and consisting of two Laminæ, between which is a cavity lined by a Serous Membrane, and termed *the Fossa of Sylvius, or Fifth Ventricle,* to which last appellation Spurzheim thinks it no more entitled than one of the Anfractuosities. In the young subject it is heart-shaped; in the old subject it is more longitudinal, and smaller in proportion. We know that the other four cavities communicate together, but no communication has been satisfactorily proved between them and the fifth. Soemmering asserts that it is shut in on every side; Santorini supposed that it opened on the base of the Brain opposite the commissure of the Optic Nerves; others, as Vicussens and Winslowe, supposed that it opened into the third Ventricle. The Wenzels have described a triangular Fossa in its posterior part, through which a bristle,

passed downwards and backwards, may be made to enter the third Ventricle. There is a case related in Baillie's Morbid Anatomy, in which this cavity and the third Ventricle were distended with fluid, while the lateral Ventricles were empty; and Dr. M^c^Dowal, one of the Surgeons of the Richmond Hospital, shewed me some years ago a Brain, in which the distention was considerable, and confined to the fifth Ventricle.

According to Cloquet, the Septum Lucidum is formed by the converging fibres of the Cerebrum, sinking down at the Raphe to be continued into the Fornix: its superior margin corresponds to the Corpus Callosum, its anterior to the reflected portion of this Commissure, and its inferior to the Fornix; its vertical depth is greatest in front.

The Corpora Striata resemble each the half of a pear cut longitudinally; their small extremities are turned backwards; they are separated from each other in front by the reflected portion of the Corpus Callosum; behind this, by the Septum Lucidum

and more posteriorly by the small anterior extremities of the Optic Thalami; externally they are continuous with the substance of the hemispheres.

On the exterior, which is of a brown or greyish colour, we observe numerous small veins, which are called the Veins of the Corpus Striatum, and contribute to form the Venæ Magnæ Galeni. By incisions into the interior, we expose a quantity of grey substance ranged in a number of Striæ that alternate with the white bands that ascend from the Olivary Bodies. The Corpora Striata are supposed by Gall and Spurzheim to be Ganglions for reinforcing the medullary fibres going to form the hemispheres.

The Optic Thalami are pear-shaped eminences, of which the anterior extremities, smaller than the posterior, are placed between the Corpora Striata, and bound the Foramina of communication of the Ventricles. Each of these bodies has an internal surface, part of which is united to a corresponding part of the internal surface of the opposite Thalamus by the

Commissura Mollis, and a superior surface which often presents a small whitish tubercle and supports the Corpus Callosum, Choroid Plexus, Velum Interpositum, Venæ Galeni, and anterior pedicles of the Pineal Gland: the remaining parts of this ganglion will be described in the order in which they presen- themselves.

The Fornix is a triangular lamina of medullary matter, convex on its upper surface; concave inferiorly. Its Apex is turned forward to meet the Apex of the reflected portion of the Corpus Callosum; its sides are bordered by a membrane, named the Choroid Plexus; its base is turned backwards, concave and free. This is the appearance it at first presents, but we will find there are other parts of it removed from view; for its Apex does not terminate abruptly in front, but divides into two processes, which sink down vertically towards the base of the Brain, passing behind a transverse band that unites the Optic Thalami, and called the Anterior Commissure. These processes, or pillars, separate from each

other as they descend, and terminate on the inferior surface of the Cerebrum in two round or pisiform heads: these are the *Corpora Mamillaria,* also called, from their white colour, the *Corpora Albicantia, Candicantia,* &c.

From the posterior angles of the base are prolonged the posterior pillars of the Fornix: they wind round the Optic Thalami, and each of them bifurcates into the Corpus Fimbriatum internally, and a short process externally that joins the posterior pillar of the Corpus Callosum to form the white substance of the Hippocampus Major.

The superior surface of the Fornix corresponds to the Septum Lucidum on the middle line, and at either side of this to the Corpus Callosum; the inferior surface rests on the Velum Interpositum, and presents on the middle line a striated appearance which has been termed *the Lyra,* owing to an error in translating the Greek word Ψαλις, which means a Fornix, but was supposed to signify a lyre, because the verb Ψαλλω means to strike the lyre. It

is formed, according to the general opinion, by the impression of the vessels in the Velum Interpositum. Gall and Spurzheim think this appearance is produced by the union of the fibres of the Fornix. We are told that the Fornix is sometimes deficient, and that this appearance is then found on the inferior surface of the Corpus Callosum.

If the Fornix be not sufficiently firm, you should pass the blade of a scissars under its anterior extremity, and divide it; then throw it back, by raising along with it the Velum Interpositum, or red Membrane, on which it lies; we then restore the Velum and thus expose the Lyra on the inferior surface of the Fornix: in raising the Velum take care not to rupture the pedicles of the Pineal Gland. If the Fornix be sufficiently firm I think a better plan would be to divide it at its junction with the posterior pillars, and then to throw it forwards; you will have, by this means, a distinct view of the anterior pillars of the Fornix, and by separating them gently you will expose the anterior Commissure which crosses

in front of them. Connected with the anterior pillars you may observe a greyish band *(the Tænia Semicirularis Geminum)* ascending outwards and backwards on either side in the Sulcus between the Corpus Striatum and Optic Thalamus, and terminating in an eminence called the Corpus Geniculatum Externum on the inferior surface of the Optic Thalamus. Some small veins will be observed separating it from the groove in which it lies.

The Digital Cavity, or *posterior Cornu* of the lateral Ventricle is placed posterior and external to its other cavities: it is curved in its course, the convexity looking outwards: it is broader in front and terminates behind in a pointed manner; its inferior wall presents *the Hippocampus Minor,* or unciform or spur-like process. This has the same form and direction as the cavity itself; it is white on its exterior, grey within; it is generally bordered along its outside by another eminence, termed its *Accessary,* from which it is separated by a longitudinal Sulcus.

The Velum Interpositum is the next part to be examined; it is a process of the Pia Mater, to the description of which I now proceed:

The Pia Mater is the most internal of the three membranes of the Brain. It forms the immediate investment of the Cerebrum, Cerebellum, and Spinal Marrow. Its internal surface has a vascular connexion with the Cerebral matter into the substance of which it is prolonged for a short distance with the vessels. Externally it corresponds to the Arachnoid Membrane, from which it is separated in some situations by the large blood vessels. In the greatest part of its extent in the Cranium it is merely a cellular stratum for the ramification of vessels. As we trace it over the Pons and into the Spinal Canal, it increases in strength, and in the inferior part of this last cavity becomes distinctly fibrous. In all these regions it is continued over the Nerves at their exit, and forms their Neurilemma.

The earlier Anatomists made no distinction be-

tween the Pia Mater and Arachnoid. Blassius is supposed to be the first who described and named the latter membrane: it is Bichat, however, that has given the most complete account of them, and proved the distinctiveness of the two membranes, by a number of arguments derived from the difference of their structure, disease, and anatomical arrangement. Thus the Pia Mater consists merely of a cellular net-work, reddish in its colour and interwoven with a vast number of blood vessels, while the Arachnoid has more of the form of a membrane, is pale, semitransparent and without blood vessels, and principally consists of exhalents and absorbents. When attacked by inflammation the Pia Mater becomes redder by the afflux of blood: the Arachnoid on the contrary becomes white, thick, and opake, and is often covered by a viscid exudation. The Pia Mater sinks into the Sulci between the convolutions, while the Arachnoid passes over them from one convolution to another. The Pia Mater, moreover, is continuous with the Neurilemma of

the Nerves ; but the Arachnoid is visibly reflected where they make their exit from the Cranium. The circumstance of the Pia Mater being raised along with the Arachnoid, is explained by the subjacent cellular substance that connects them, and the Pericardium Pleura and Peritoneum have similar adhesions.

The Pia Mater sends three principal prolongations into the interior of the Cerebrum: first, from the base of the Brain it sends up two prolongations, one on either side. These ascend through the Fissures between the Tractus Optici and middle Lobes of the Cerebrum, and having passed through the inferior Cornua into the bodies of the Ventricles, they form the Choroid Plexus which you see now exposed.

The third prolongation is *the Velum Interpositum,* the formation of which may be explained as follows:

They layer of the Pia Mater that descends behind the posterior margin of the Corpus Callosum,

meets the Layer that ascends on the superior surface of the Cerebellum, and both together enter *the Transverse Fissure,* between the great Commissure above and the Vermiform process below, involving the Venæ Magnæ Galeni throughout their entire course. From this point the Pia Mater is continued forwards, under the form of a triangular Membrane, termed the Velum Interpositum. In passing over the tubercula quadrigemina, the Pineal Gland is enveloped by it, except the parts where its Pedicles go out, and this gland is therefore related to the Pia Mater precisely as the Pituatary Gland is to the Dura Mater. In front of the Pineal Gland, this membrane presents on its inferior surface an opening, by which the Arachnoid is transmitted to line the Ventricles. In front of this opening, is placed a cluster of cerebral Protuberances, grouped in the form of a triangle, the Apex of which is turned forwards.

The superior surface of the Velum corresponds to the Fornix in front, and to the Corpus Callosum

posteriorly. Its inferior surface covers the Optic Thalami and Pedicles of the Pineal Gland; its base is continuous with the external Pia Mater; its margins are free, as far forwards as the inferior Cornua of the lateral Ventricles: in front of this they are connected to the sides of the Choroid Plexuses. You may observe that the Choroid Plexuses of the right and left sides are continuous with each other, opposite the Apex of the Velum, by meeting in a foramen or short canal, described by Monro. This communication is bounded above by the Neck or Apex of the Fornix, inferiorly by the Apices of the Thalami, and in front by the anterior Pillars of the Fornix. Between these Pillars is a vertical Fissure, through which a probe may be passed downwards and forwards into *the Infundibulum* or deepest part of the third Ventricle.

Bichat has shewn, that there is a short Canal in the posterior part of the Velum, for transmitting a tubular process or hollow Cylinder of Arachnoid

Membrane to the third Ventricle; from which it is afterwards prolonged into the other Ventricles, through the communications already described. If the point of a probe be made to enter the middle of the transverse Fissure, and be pushed downwards and forwards, it will pass through this Canal:—first between the Venæ Galeni above, and Pineal Gland below: its point will then descend between the Pineal Gland behind and the groups of cerebral protuberances in front. On looking for the word Arachnoid in the Index, you will find a reference to Bichat's description of this Canal, translated from the French.

The Pineal Gland is the small body that you may observe resting on the anterior tubercula quadrigemina and head of the superior vermiform process of the Cerebellum, enveloped by the Velum Interpositum, and supporting the posterior margin of the Fornix. It derives its name from its resemblance in shape to a Pine Apple. Its broad extremity or base is turned forwards, and its

small extremity backwards; its colour is grey, and its consistence soft and pulpy. According to Meckel, there is a cavity in its interior open-opening on the inferior surface of the Gland towards the third Ventricle. It is sufficiently easy to demonstrate two medullary prolongations continued forwards from its base along the superior and internal margins of the Thalami to terminate in the anterior Pillars of the Fornix, These are termed *the anterior Pedicles.*

Meckel describes two other prolongations from its base, which accompany the preceding for a very short distance forwards, and are then reflected to terminate by uniting on the middle line in front of the Nates, forming what he terms *the Lesser Posterior Commissure.*

According to Gall and Spurzheim, there are besides the Anterior Pedicles, two other processes that are directed downwards and backwards, from the base of the Gland to terminate in the tubercula quadrugemina: these are *the Posterior Pedicles.*

The Use of this body is entirely unknown: it has received great celebrity from the circumstance of Descartes supposing it to be the seat of the soul.

In the interior, and often on the outside of it, a quantity of yellowish sand has been observed, which is principally composed of Phosphate and Carbonate of Lime. Sœmmering terms this the *Acervulus:* he has proved that it is by no means a morbid appearance, as previously supposed, but that it belongs to the healthy state of the *human* Brain, and is almost proper to man. He observes that it first appears at the 14th year, after which it is almost always found in the Pineal Gland of the human subject. These opinions, however, must be received with some limitations, for Sœmmering himself has found the Acervulus in the fallow Deer, and Malacarne in the Goat. The Wenzel's moreover have observed it so early as the seventh year in the human Brain, and they relate six cases in which it was deficient after the age of fourteen.

The Venæ magnæ Galeni, two in number, are formed by the union of two veins on each side; viz. *the Vein of the Corpus Striatum* and *Choroid Vein.* The first of these is situated, along with the Tænia Semicircularis, in the groove between the Corpus Striatum and Optic Thalamus: it collects the blood from the veins observed on the surface of the former body, and is directed inwards and forward towards the anterior pillar of the Fornix; here it meets the Choroid Vein which collects the blood of the Choroid Plexus and Velum Interpositum, and which takes a direction forwards and inwards along the side of the Fornix to gain the preceding. The Vena Galeni, which results from their union at first proceeds forwards and then winds inwards and backwards to accompany the corresponding vein of the opposite side. It then enters the anterior extremity of the straight sinus in either crossing or uniting with its fellow, or forming a kind of plexus with it.

Let us now proceed to examine *the Inferior*

Cornu, to which, the Choroid Plexus will be our guide. Along this we pass the wetted handle of a knife, and raise the superjacent portion of the middle Lobe. This cavity is bounded on the inside by the Optic Thalamus; its floor is formed by the Hippocampus Major (an oblong lamina resembling a Convolution); and superiorly and externally it is bounded by the middle Lobe. We found the Plexus Choroides of the right and left sides continuous with each other, under the anterior extremity of the Fornix; we then saw each of them passing backwards in a groove between the Fornix and Optic Thalamus, and found they were united to the sides of the Velum Interpositum. We now find this groove or fissure continued into the inferior Cornu, between the Optic Thalamus and posterior pillar of the Fornix; and observe, that here also the Choroid Plexus lies over it: anteriorly and inferiorly it even penetrates into it, and descends to the base of Brain to be continuous with the Pia Mater on the exterior. You are not, how-

ever, to suppose that the Ventricle is open inferiorly; it is closed by two layers of Arachnoid Membrane, for in the Ventricle, the Choroid Plexus is surrounded on all sides by the Arachnoid, and when it is going out (or entering if you please) inferiorly, the Arachnoid is reflected on the Parietes of the Inferior Cornu: this is the first layer that closes the ventricle; the second layer is the Arachnoid belonging to the base of the Brain, which does not enter this fissure with the Pia Mater, but passes over it as it does over the Anfractuosities.

From this account, it appears, that the Arachnoid Membrane, so far as we yet know, gets into the cavities only at one place, and that the Pia Mater enters at three places;—first, to form the Velum Interpositum it enters by the transverse fissure between the Corpus Callosum and Cerebellum; and next, to form the Choroid Plexus, it enters the fissures at the bottom of the Inferior Cornua, which are continuous with the transverse fissure, and form with it *the Great Cerebral Fissure*

of Bichat, which will consequently be curved in its course, having the convexity turned backwards, and will extend from one hemisphere to the other.

The Hippocampus Major commences at the anterior extremity of the Hippocampus Minor, and opposite the posterior extremity of the Corpus Callosum. It is narrow at first, but becomes broader as it descends, winding round the Optic Thalamus, and terminating below in a flatted tubercle, subdivided on the superior surface into little processes resembling toes: hence, the tubercle is called the *Pes Hippocampi.* The Hippocampus Major presents a concavity turned forwards and inwards, and a convexity in the opposite direction. Its outer margin is bordered by another longitudinal eminence, termed its accessary. On its internal margin, we observe the Corpus Fimbriatum, resting in the form of a white narrow band, winding round the Optic Thalama: this we already know to be the internal division of the posterior pillar of the Fornix. The Hippocampus Major and minor form,

by their junction, an angle that is hollow externally where it receives a triangular process of the Brain that has got no name.

The Hippocampus Major has been considered by some as a prolongation of the Fornix. Haller and Sœmmering make it come fro m the Corpus Callosum, and according to Vic D'Azir, it is nothing more than a cerebal convolution of a peculiar form. Chaussier (I think) gives a true account of the matter, and shews how these opinions may be reconciled. "We find it," he observes, "composed, —first, of a white thin fibrous substance which covers it like a rind, and is easily separated: in tracing this investing Lamina, we find it comes evidently from the Corpus Callosum, and that there is joined to it some other Fasciculi from the posterior angle of the Fornix;—secondly, of a grey pulpy substance, similar to the other convolutions of the Brain: this forms its body and principal part, and is bifurcated at its posterior extremity under the posterior fold of the Corpus Callosum; it divides

into two little branches, one of which is continuous with a convolution of the posterior lobe, and the other shorter with one of the middle lobe."

The Posterior Pillar of the Fornix winds round the Optic Thalamus, and divides into two portions: the external and shorter we have just now seen contributed to form the white substance of the Hippocampus Major. The internal is the *Corpus Fimbriatum,* a long white band that embraces the convexity of the Thalamus, and rests on the internal margin of the Hippocampus Major.

On raising this band, we bring into view a groove, which is found between the Corpus Fimbriatum above, and a broad portion of Medullary substance below (viz. the most internal part of the greater Hippocampus). Now in the hollow angle between these at the bottom of the groove, and under the Corpus Fimbriatum, is *the Fascia Dentata,* no less remarkable than the Corpus Fimbriatum itself. It was first described by Tarin. Vic D'Azir called it the portion codronnè or internal

denticulated edge of the horn of Ammon. Bichat takes particular notice of it, and desires you to expose it by cautiously raising the Pia Mater and blood vessels. Its grey or reddish colour will enable you to distinguish it from the white band, termed the Corpus Fimbriatum, which it resembles in its form and direction, and under the internal margin of which it lies.

The Third Ventricle is the eliptical fissure that separates the Optic Thalami. When these bodies are gently drawn asunder we expose and elongate a cineritious band, which unites them, and which, on account of its extreme delicacy, is termed the *Commissura Mollis. The anterior boundary* of this Ventricle is formed above by a transverse medullary cord, termed the Anterior Commissure, and lower down, by a peculiar membrane that extends from the commissure of the Optic Nerves to the Corpus Callosum. *The posterior boundary* is formed by a similar transverse medullary cord, termed the Posterior Commissure. *The sides* are formed by the Optic Tha-

lami; *the roof* by the Velum Interpositum; and *the floor,* which is the longest of its walls, is formed from before backwards by the Tuber Cinereum, Corpora Albicantia, and Locus Perforatus. The fissure that separates the Optic Thalami extends under the Fornix from the anterior to the posterior Commissure. Now the most anterior part of this fissure is termed the *Foramen Commune Anterius;* it is consequently bounded *on the sides* by the Optic Thalami; *anteriorly* by the anterior Commissure, beneath which it communicates with the Infundibulum; *posteriorly* it communicates with the third Ventricle; and *superiorly* with the short canal described by Monro. When you find this Foramen Commune Anterius, described in books as communicating posteriorly with *two* oval openings, you will remember that they are only the *orifices* of the above canal. Under the posterior Commissure, and between the pedicles of the Pineal Gland you will observe the *Foramen Commune Posterius.* We can now easily enumerate the parts met on the middle line of the Brain from above

downwards, viz. the Falx, Arachnoid, Pia Mater, Raphe and Corpus Callosum, Septum Lucidum, Fornix, Velum Interpositum, third Ventricle, (including the Commissura Mollis,) and the floor of the third Ventricle, consisting of the parts just enumerated.

Let us now examine a little more in detail the parts that bound this Ventricle; first, on separating the anterior pillars of the Fornix, we expose the *anterior Commissure;* this is cylindrical in the centre but becomes flat as we trace it into the Hemispheres; it has the form of an arch convex anteriorly. According to Chaussier and Tiedeman, its extremities may be traced into the Crura Cerebri,* from which it was in fœtal life prolonged, and therefore

* Spurzheim conceives this to be an error: he observes, that "in all the Mammalia the anterior Commissure is composed of "two parts; the one of these communicates with the Olfactory Nerve, the other is prolonged towards the fissure of "Sylvius, between the anterior and middle lobes; the portion "running to the Olfactory Nerve forms an arch, the convexity "of which is turned backwards."

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cannot be a Commissure of Spurzheim's converging fibres, the existence of which Tiedeman denies.

The posterior Commissure is thicker and shorter than the anterior; it cannot be traced into the hemispheres, but appears to be immediately lost in a quantity of grey matter; it is placed in front of the Tubercula Quadrugemina before and under the Pineal Gland: it forms a common boundary of the Brain and Mesocephale. In tracing these commissures you should not use the cutting edge, but rather scrape with the handle of your scalpel the grey substance in which they are imbedded.

In order to get a complete view of the Tubercula Quadrugemina, it will be necessary to remove the superior vermiform process of the Cerebellum, for which reason I shall describe this process and the upper surface of the lateral portions, or hemispheres, before we proceed farther.

The superior surface of the Cerebellum is exposed by cutting the Tentorium from before backwards by two incisions, one at either side of, and parallel

to the base of the great Falx. This surface, examined on the middle line, is inclined from above downwards and backwards; and at either side it is inclined from the same point downwards and outwards. It is covered immediately by a vascular Pia Mater continuous with the Velum Interpositum, and presents on the middle line from before backward an elongated eminence, termed the Superior Vermiform Process. Gall and Spurzheim call this the fundamental part, or primitive lobe, of the Cerebellum, because it is found even in those animals that want the lateral portions. Its anterior part is called its head, and contributes to fill up the oval opening of the Tentorium; posteriorly it terminates at the fissure that receives the lesser Falx. A number of short Anfractuosities are observed on its surface passing from side to side in a curved direction, the convexity looking forwards; these curvatures however are not always evident or regular, they are continuous with Anfractuosities on the lateral por-

tions or hemispheres of the Cerebellum that have their convexities turned in the opposite direction.

The hemispheres are bounded in front by the margin of a great semilunar notch extending from right to left; posteriorly and externally, by thin convex margins that meet behind at the fissure for the lesser Falx, and terminate in front in the semilunar notch; finally, they are bounded on the inside by slight furrows that separate them from the superior Vermiform Process. The superior surface of each hemisphere is convex from before backwards, and concave from side to side; it presents a number of lobes, lobules, and laminæ, that have been variously classed and described by different writers. The Laminæ observable on the upper surface are placed so as to have each an anterior surface concave, and a posterior surface convex which corresponds to the concavity of the Lamina behind it; their thickness is from a line to a line and half; they are concentric, and their common centre is referable to a point, somewhat anterior to the head of the Vermiform

Process; the number of them on the superior surface of each hemisphere varies from thirty to thirty-five.

Though all the primitive laminæ are separated by fissures, yet some of these are much broader and deeper than the rest, and serve to separate fasciculi, or groups of from two to six laminæ that are termed *Lobules.* The anterior Lobule consists of laminæ that are shorter and more curved than the rest, and continuous with the laminæ of the opposite hemisphere by passing over the Vermiform Process, where they become thicker and more prominent so as to form its head: the other four lobules are behind this; they are longer, less arched, and their laminæ terminate in the different ways to be enumerated.

Each lamina terminates externally at the convex margin of the Cerebellum; internally it may terminate in any of the following ways: first, it may be continuous with a corresponding lamina of the opposite hemisphere (in this way most of the anterior laminæ terminate); or it may cross the Vermifrom Process and terminate between two laminæ of the

opposite hemisphere; or it may terminate in a pointed manner at the bottom of an Anfractuosity, so that its internal extremity will not be seen on the surface; or lastly, it may terminate on the middle line. On this variety of disposition depends the external appearance of the Vermiform Process.

On separating the *primitive* laminæ (or those that reach the surface) we bring into view others that are *secondary.* These resemble the primitive in their form, but they are smaller and thinner; some of them are barely a line in height, others ascend higher; they are all united at their bases to the primitive laminæ. Lastly, the lobules themselves are collected into *lobes,* of which there are four on the superior surface of the Cerebellum, viz. two on the right, and two on the left hemisphere. The two anterior are called *the Square Lobes,* and the two posterior are *the Semilunar Lobes.* The boundaries of the Square Lobe are—on the middle line the Vermiform Process, externally and anteriorly the external and anterior margins of the Cerebellum

and posteriorly a fissure that separates it from the second or Semilunar Lobe, which is itself bounded in front by the square Lobe, and behind by the convex margin of the Cerebellum and fissure for the lesser Falx.

Hence it appears that each Hemisphere is formed, 1st, of primitive Laminæ amounting on the upper surface to be between 30 and 35, and on the inferior surface to be between 25 and 30.—2dly, of secondary Laminæ, the number of which on each hemisphere is 300 to 350. The Laminæ are farther grouped into Lobules, of which there are four on the inferior and five on the superior surface of each Hemisphere. The superior lobules, and the Lobes into which they are collected, have been described in the two preceding pages. The inferior lobules (which are not collected into Lobes) together with the remaining parts of the Cerebellum, will be described at page 119.

You may now push off successive strata of the head of the Vermiform Process till you completely

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expose the posterior of the Tubercula Quadrugemina, and also two cylindrical processes that pass downwards and backwards from them: these latter are the *Processusa Cerebello ad Testes;* they are separated by a delicate grey lamina, termed the Valve of Vieussens. These parts we will now examine in order.

The Tubercula Quadrugemina are lodged in the semilunar or anterior notch of the Cerebellum; they correspond—*superiorly* to the Pineal Gland in front, and Vermiform Process behind; *inferiorly* they form part of the roof of the aqueduct of Sylvius, and are connected with the olivary fasciculi of the Crura Cerebri; *in front* of them is the posterior Commissure, and *posteriorly* they are connected with the Valve of Vieussens, and Processus ad Testes. The four tubercles are separated on the superior surface by a crucial fissure; the two anterior of them (formerly called the *Nates*) are larger, rounder, and more prominent than the posterior. Gall and Spurzheim have succeeded in tracing the roots of the Optic Nerves arising from them. These anterior

tubercles are so large in birds that they were mistaken for the Optic Thalami; and hence the Optic Nerves were said to arise from the Thalami. Vic D'Azir has observed that in birds (whose sight is their most acute sense) there are ventricles in these bodies in the same way as the Mammalia (whose sense of smell is the most acute) have in the Olfactory Nerve. The posterior tubercles, also called *Testes,* give origin to two bands (one on each side;) each band descends forming an angle with the root of the Optic Nerve, after swelling out to form the Corpus Geniculatum Internum it seems to pass under the root of the Optic Nerve, and can be traced no farther. Some suppose it to be a root of the Olfactory Nerve: this opinion is strengthened by a circumstance noticed in the Report of the Committee of the National Institute of France, that the Corpora Geniculata Interna, as well as the posterior tubercula quadrugemina, are larger in Carniverous Animals in whom the Olfactory Nerve is so conspicuous, than in others. Spurzheim however denies that this

is the case, and moreover, there is opposed to this opinion a circumstance noticed by Dr. Gall and Spurzheim, as well as the committee, namely, that in Dolphins and Porpoises (which have no Olfactory Nerve) the posterior tubercula are very large. In his Physiognomonical System Spurzheim says it certainly cannot be a root of the Olfactory Nerve.

The Processus a cerebello ad testes are two nearly cylindrical processes, continued downwards and backwards from the white substance which surrounds the posterior of the tubercula quadrugemina. They diverge a little as they descend, and consequently the Valve of Vieussens, that is placed between them, will be broader below than above. At their posterior inferior extremities they unite with the Valve of Vieussens, and form a broad flat expansion that penetrates the Cerebellum. On the sides of these processes near their posterior parts the Crura Cerebelli may be seen converging in front to form the Pons. *The Valve of Vieussens* is a delicate triangular lamina, the Apex of which is turned

upwards and forwards. Its inferior surface forms the Roof of the Aqueduct of Sylvius, the superior surface is grey, and marked anteriorly by transverse white lines, which are the Roots of the fourth pair of Nerves.

After the Valve of Vieussens has entered the semilunar Notch it continues to go backwards, but not to descend. In this situation it forms the Roof of the fourth Ventricle, and then penetrates the Cerebellum, in passing over a little tubercle termed the body of the Inferior Velum. This tubercle is found at the most anterior part of the inferior Vermiform Process in the interior of the fourth ventricle, and will be seen in opening that Cavity hereafter. At present you may examine the boundaries of the Canal of communication between the third and fourth Ventricles; for this purpose introduce a probe into the Foramen Commune Posterius under the posterior commissure; push it gently downwards and backwards, and it will arrive in the fourth Ventricle. This Canal is termed

the *Aqueduct of Sylvius* or Iter ad tertio ad quartum Ventriculum. The probe is at this moment placed in the Axis or centre of a Conical Mass termed *the Mesocephale or Nodus Cerebri.* The superior part of which is formed by the Tubercula Quadrigemina and Valve of Vieussens; the inferior part by the Pons Varolii or Annular protuberance, and the lateral parts by the processus ad testes. You may observe that the Brain is placed above it (with the interposition of the Posterior Commissure); that the Cerebellum is behind it, and that the Spinal Marrow is beneath it; so that it is placed in a central situation, from which circumstance it derives its name.

In order to expose the inferior surface of the Brain it will be necessary to remove it from the Cranium. For this purpose, turn the subject on its back, allow the Head to hang over the edge of the table. Place a wet cloth on the palm of your left hand, and with this give a moderate support to the Brain, allowing it to gravitate a little occasionally,

in order to expose the parts that connect it to the Base of the Cranium; then employing a Scalpel with a long handle, and either sitting low or kneeling, you will divide from before backwards:—1st, the Olfactory Nerves;—2dly, the Optic Nerves and Ophthalmic Artery;—3dly, the Carotid Arteries;—4thly, the Pituatory Process (or if practicable, you should scoop it out from the Sella Tursica);—5thly, the Motores Oculorum, which you will see entering beside the Cavernous Sinus;—6thly, the Trochleators, which are very small, and will be observed along the edge of the Tentorium. You then draw the Brain gently aside and incise the Tentorium along the superior edge of the Petrous Bone; afterwards make a similar section to meet it on the other side: you then continue and divide successively the 5th, 6th, and 7th pair of Nerves, and a little farther back and more internally the Glosso Pharyngeal and Par Vagum; near the Foramen Magnum you meet the ninth pair and Spinal Accessary; you then sink the knife deep into the Spinal Canal, and divide the

Spinal Marrow, Vertebral Arteries, and Suboccipital Nerves. If the Brain be not sufficiently firm now, you immerse it for some time in a solution of Nitre, or Alum, or Corrosive Sublimate. But remember that the coloring matter of the grey substance will probably be discharged by this process.

The inferior surface of the Brain presents on the middle line from before backwards,—1st, a Fissure separating the anterior Lobes, and continuous with the great longitudinal Fissure observed on the upper surface;—2dly, behind this, a remarkable Anastamosis of Arteries termed the Circle of Willis, and covered by Arachnoid Membrane, which must be destroyed to get a distinct view of the vessels;—3dly, a transverse Lamina of medullary matter termed the Pons, which is crossed from behind forwards by a trunk called the Basilar Artery, and which communicates in front with the posterior part of the Circle of Willis; behind the Pons is the head of the Spinal Marrow, or the Medulla Ob-

longata of Haller; and most posteriorly is the Cerebellum.

The lateral portions or hemispheres of the Cerebrum are divided each into an anterior, a middle, and a posterior lobe: Haller admits only two lobes.

The anterior is separated from the middle lobe by the Fissure of Sylvius, into which sinks the lesser wing of Ingrasias: it is into this Fissure that we trace the middle branch or continued Trunk of the internal Carotid Artery, and the roots of the Olfactory Nerve. Its direction is upwards and backwards in such way, that the anterior lobe (when the subject is erect) rests on the middle lobe. Another Fissure is described (see Cloquet 2, p. 532) as separating the middle from the posterior lobes; but I believe it is very seldom we find any distinct line of demarcation between these: that part of the hemisphere that lies on the Tentorium will, however, be called the posterior lobe; and the middle lobe is interposed between this and the Fissure of Sylvius.

Compare these parts now with the Base of the Skull, and observe what part in each corresponds to the other. First, you will find that the Cribriform Plate of the Ethmoid Bone supports the bulbous extremities of the Olfactory Nerves. The square Plate of Bone between this and the Sella Tursica supports these Nerves in the first part of their course, and also the two convolutions that separate them. Behind this is a transverse groove which lodges part of the Commissure of the Optic Nerves, and still more posteriorly is the Sella Tursica for lodging the Pituatory Gland. On the sides, the anterior Fossæ are formed by the orbitar processes of the Frontal Bone, and the lesser wings of the Sphenoid. The Circle of Willis surrounds the Sella Tursica, and lies over a circle of Sinuses, that has much resemblance in its form to the Arterial Circle. The middle Fossæ of the Cranium are formed by the greater wings and spinous processes of the Sphenoid Bone, by the superior surface of the petrous portion of the Temporal Bone,

and part of the inner surface of its squamous portion. These Fossæ support the middle lobes of the Brain and Casserian Ganglion. The cuneiform process of the Occipital Bone supports the Pons Varoli with the interposition of the sixth pair of Nerves, transverse Sinus, Bassilar Artery, and inferior Artery of the Cerebellum : behind this it supports the Medulla Oblongata of Haller, from which it is separated by the vertebral and anterior Spinal Arteries. The posterior Fossæ of the Cranium are formed by the inferior part of the Occipital Bone and posterior surface of the Petrous Bone: they support the hemispheres of the Cerebellum.

The inferior surface of the Brain, like the superior, is marked by convolutions, which however more generally assume a longitudinal direction than those on the upper surface, and those near the middle line are nearly parallel. The Convolutions at the Base are likewise more uniform and constant: two of them may be always found, viz. one on each anterior lobe, parallel and in contact with each other.

Between them is the anterior inferior termination of the great Longitudinal Fissure, and they form the internal boundaries of the grooves in which the Olfactory Nerves are lodged.

The Fissure of Sylvius on one side is separated from that of the opposite side by the Commissure of the Optic Nerves. From the front of this Commissure, ascends *a little membrane* to the anterior part of the Corpus Callosum: this membrane closes the lower and anterior part of the third Ventricle; it is greyish, transparent, pulpy though firm, and possesses little Vascularity. Behind the Commissure of the Optic Nerves is a mass of cineritious matter, containing a nucleus of white substance in its centre, bounded laterally by the Tractus Optici or Optic Nerves before their junction; posteriorly by two white little bodies (the Corpora Albicantia) which they usually envelop and conceal. This grey mass is the *Tuber Cinereum* of Sœmmering; it has been also termed *the Ganglion of the Optic Nerves.*

From the centre of the Tuber Cinereum descends

the Pituatory Process (Tige Pituataire) a red delicate conical prolongation that terminates by its Apex in the Pituatory Body or Gland. In this course it passes from behind forwards under the commissure of the Optic Nerves. It is not hollow, as has been imagined by some anatomists, who supposed the cavity of the Infundibulum to be continuous with a canal in this: others have doubted whether the Infundibulum itself was hollow; but Professor Murray of Upsal, having frozen the Brain found a canal in it filled with ice; and De Haen, in his Ratio Medendi, (Vol. VI., p. 271,) found it dilated and filled with a calcareous matter. This process affords a medium of communication between the Arachnoid of the Brain and Dura Mater. The *Pituatory Gland* is somewhat round; its long axis, placed transversely, is lodged in the Sella Tursica, and nearly enveloped by Dura Mater; this covering, however, is deficient on the upper part to admit the Pituatory Process. The Cranial Arachnoid Membrane is separated from the Dura Mater in this

situation by the gland; every where else it is in close contact with it. This body consists of two portions, an anterior and a posterior; the anterior is the larger; it is convex in front, concave behind: the posterior portion is soft in its consistence, and impregnated with a whitish viscid fluid. The ancients supposed it to be of a glandular structure, and destined to filter the serosity of the Brain: Spigelius imagined he had discovered its excretory ducts.

The Corpora Albicantia are white on their exterior, grey within: they are the terminations of the anterior vertical pillars of the Fornix; they are free below, united together above by a cineritious band, easily torn, that forms part of the floor of the third Ventricle; in front they correspond to the Tuber Cinereum, behind they are united to the Locus Perforatus to be described just now, and laterally to the Crura Cerebri; they are continuous with the Tænia Semicircularis and Pedicles of the Pineal Gland. Behind these bodies, and between the Crura Cerebri, is a triangular space termed the *Locus Niger;*

and on looking a little deeper into this Fossa, we perceive a horizontal lamina of white substance uniting the internal edges of the Crura Cerebri. This forms the posterior part of the floor of the third Ventricle; it gives origin to a portion of the third pair of Nerves, and having many Foramina for the transmission of blood vessels, it has been called the *Locus Perforatus.* It is at the posterior part of this space, and immediately in front of the Pons, that we find the opening which anatomists have named the *Foramen Cæcum Anterius,* to distinguish it from the *Foramen Cæcum Posterius,* which is found on the middle line immediately behind the posterior margin of the Pons.

I have already directed your attention to the superior part of the *Mesocephale* formed by the Tubercula Quadrugemina and Valve of Vieussens, also to its lateral portions, or Processus ad Testes, and you have now exposed the Pons Varolii, which forms the remaining or inferior part of it. The Mesocephale, consisting of these parts, has the form of a truncated

ovoid; its anterior inferior surface rests on the cuniform process of the Occipital Bone, from which it is separated by the Basilar Artery, inferior artery of the Cerebellum, and sixth pair of Nerves. Its posterior superior surface gives origin to the fourth pair of Nerves and supports the Pineal Gland and Superior Vermiform Process of the Cerebellum. The superior extremity, larger than the inferior, receives on its sides the Crura Cerebri, and corresponds to the Locus Niger, Locus Perforatus, Optic Thalami, third Ventricle, and posterior Commissure; the inferior extremity, smaller, receives the Corpora Pyramedalia and Olivaria, which appear contracted in size as they enter it, and corresponds to the posterior fibres of the Spinal Marrow, (viz. the Corpora Restiformia,) which pass upwards and backwards towards the Cerebellum. Finally, the Mesocephale is placed between the Cerebrum, Cerebellum, and Spinal Marrow. It is much firmer in its consistence than any of these, and does not amount to more than from a sixtieth to a sixty-fifth part of the whole

weight of the Cerebral Matter in the Cranium and Spinal Canal.

The Brain is supplied by a very considerable *quantity of blood.* Haller calculates that one-fifth of the blood expelled from the left Ventricle is sent to this organ. Though the quantity required is great, yet it is equally necessary that it should be conveyed in the gentlest manner. We find accordingly many provisions to diminish its impetus: first, it does not arrive by one, but by four trunks; secondly, the blood in man ascends against its gravity; a third provision is the tortuous course of the vessels in entering the Cranium; a fourth, its passing through a rigid bony canal; a fifth, its anastamosis to form the Circle of Willis; and a sixth, the vessels ramifying to an extreme tenuity on the Pia Mater, before they enter the substance of the Cerebrum. You may observe, that the arteries of the Brain have no cellular sheath; that their fibrous coat is extremely weak, so that it collapses like a vein; and that the arteries are placed at the base of the Brain, while the veins take a sepa-

rate course on its superior surface. Mr. Hunter, however, observes, that this is not the case with the smaller branches, for they accompany the veins through the Cerebral Substance. Sir Everard Home's opinion, as to the valves of these small veins, will be noticed hereafter.

The arteries that supply the Brain are the Internal Carotid and Vertebral: *the Internal Carotid* ascends through the Cavernous Sinus, surrounded by a plexus of nerves that come from the Sympathethic in the Neck, and join the fifth and sixth pair, as will be more particularly described in examining the Cavernous Sinus. This artery, (after giving off the Ophthalmic) divides at the side of the Sella Tursica (or at the side of the commissure of the Optic Nerves as you look on the base of the Brain) into three principal branches. The middle, from its size, might be considered the continued trunk; it passes into the fissure of Sylvius, taking a direction outwards and backwards. It first gives a great number of branches to the inferior part of the Brain, to the

Pia Mater, covering the Crura Cerebri, and gives one or more choroid branches that accompany the choroid plexus unto the inferior cornu of the Lateral Ventricle, and then divides in the fissure of Sylvius into two considerable branches for the anterior and middle lobes of the Brain. These follow the fissure outwards and backwards, and terminate near the posterior part of the Brain by numerous sub-divisions. Some tortuous twigs are given off which sink into the anfractuosities and supply the Pia Mater; others appear to perforate and surround the roots of the Olfactory Nerve.

The *Anterior Artery of the Cerebrum* passes forwards between the first and second pair of nerves, to reach the great Longitudinal Fissure; it then ascends with its fellow of the opposite side between the anterior lobes of the Brain, and in front of the anterior part of the Corpus Callosum, along the upper surface of which it runs and then descends behind it so as nearly to circumscribe this commissure. The branches, from its concavity, are smaller, and distributed to

the Corpus Callosum ; those, from its convexity, are more considerable, and supply the internal surfaces of the hemispheres, as already described.

The anterior arteries of the Cerebrum are connected together by one, two, or more transverse branches that complete the Circle of Willis in front; these are called the *Anterior Communicating Branches* where there is but one—it is a large vessel ; if more they are proportionably smaller. The third branch, to be described, of the internal Carotid Artery, is called the *Posterior Communicating Branch.* It is smaller than either of the preceding, and is usually given off before them; it passes backwards and inwards to anastomose with the posterior artery of the Cerebrum, which is itself a branch of the Basilar Trunk.

You have now a view of the arterial anastomosis which has been termed *the Circle of Willis.* Its figure, however, is not circular, it is rather a polygon, formed in front by the anterior communicating branches; next, as you trace it backwards on either

side, by the anterior artery of the Cerebrum, then by the trunk of the internal Carotid, next by the posterior communicating branch, the posterior artery of the Cerebrum, and lastly, by the anterior extremity of the Basilar Trunk.

The Vertebral Artery enters the Cranium by perforating the posterior Vaginal Ligament, which, according to Weitbrecht, sends off a prolongation that converts the groove of the Atlas into a canal. In this canal are lodged the Vertebral Artery, and beneath it the Sub-occipital Nerve. As for the Vertebral Vein, which ascended with the artery through the foramina of the transverse processes of the Cervical Vertebræ, we cannot trace it as a trunk beyond the interval between the Atlas and Occiput, for here it terminates in (or strictly speaking is formed by) a number of small branches without the Cranium; one small vein, however, connects it to the Lateral Sinus in passing (not with the artery) but through the posterior Condylord Foramen which opens internally on the Occipital Bone in the track

of this Sinus. After the Vertebral Artery has penetrated the posterior Vaginal Ligament, it takes a direction upwards, forwards, and inwards, separated at first from the ninth pair by the first dentated ligament, below the level of which it enters : it next passes upwards and inwards before this ligament while the Spinal Accessory Nerve passes upwards and outwards behind it, and consequently crosses the course of the artery : here the Vertebral sends its inferior artery of the Cerebellum backwards and outwards between the Par Vagùm and Spinal Accessory Nerves, and then continues to ascend towards the middle line in front of the Ninth Nerve, the Olivary, and the Pyramidal Bodies, and behind and above the Occipital Bone. It then joins its fellow at an acute angle to constitute the Basilar Artery. The junction of these arteries takes place at the posterior margin of the Pons, and separates the origin of the sixth nerve of the right side from that of the left.

The Basilar Artery thus formed, passes forwards

on the middle line under the Pons, and divides at the anterior margin of this commissure into four branches; two to the right side, viz. the superior artery of the Cerebellum and the posterior artery of the Cerebrum; and two similar arteries to the left side.

The posterior artery of the Cerebrum is considerably larger than the superior of the Cerebellum. It winds outwards round the Crus Cerebri, and then passes upwards and backwards, following in the first part of its course the direction of the fourth pair of nerves; it afterwards passes above the superior vermiform process of the Cerebellum to the inferior surface of the Cerebrum. Its branches are distributed to the inferior surface of the posterior lobe of the Cerebrum. Immediately after its origin it gives branches to the Corpora Albicantia and Crura Cerebri: one branch enters the third ventricle and is distributed to the Optic Thalamus, the tuber cinereum and anterior pillars of the Fornix. Where it begins to wind round the Crus Cerebri, it receives

the *posterior communicating branch* of the internal Carotid, or *Communicans Willisii.* Its ultimate branches sink into the Anfractuosities, and spread on the Pia Mater like the other cerebral arteries.

The superior artery of the Cerebellum winds round the Crus Cerebri, accompanying the preceding vessel, from which it is occasionally separated;—first, by the third nerve; next, by the fourth; and lastly, by the Tentorium. Having reached the superior surface of the Cerebellum, it divides into a great number of branches, some of which pass over the Tentorium to the inferior surface of the Brain; but the greatest number under the Tentorium to the superior surface of the Cerebellum, where, after minutely sub-dividing, they are distributed to the Pia Mater, and anastomose with the branches of the inferior artery of the Cerebellum. In this course it supplies the Pons, Crus Cerebri, Tubercula Quadrugemina, Pineal Gland, Velum Interpositum, Choroid Plexus, and the Valve of Vieussens: one branch of it may be observed to enter the internal

auditory Foramen, separating the facial from the auditory Nerve.

The arteries given off by the Vertebral before their junction, and by the basilar Trunk, are the inferior arteries of the Cerebellum, and the spinal arteries.

The inferior arteries of the Cerebellum generally come one from the vertebral Artery, and the other from the basilar Trunk: both however, though rarely, may come from the Vertebral, or still more rarely, from the Basilar. The inferior artery of the Cerebellum takes a direction tranversely outwards, crossing the pyramidal body; it then passes backwards between the Par Vagum and spinal accessory Nerves to the inferior surface of the Cerebellum. Its first branches (very small) are distributed to the superior extremity of the Spinal Marrow, the origins of the eighth and ninth pair of nerves, and to the fourth Ventricle; the last, more considerable, creep along the inferior surface of the Cerebellum to its circumference, where they communicate with

those of the superior artery of the Cerebellum. A few of the branches enter the Anfractuosities; the rest form a delicate net-work on the Pia Mater. The spinal arteries will be described when we come to the spinal Canal.

Let us now proceed to examine the nerves. *The Olfactory, or first pair of Nerves,* arises by three roots, two of them medullary, and the third cineritious. Of the medullary roots the external is the longer; it may be traced taking a direction outwards, upwards, and backwards, in the fissure of Sylvius, placed above the tortuous branches of the internal carotid Artery. It arises from the outer part of the Corpus Striatum, and is first seen at the junction of the anterior with the middle lobe, surrounded by a number of foramina for vessels, and sometimes presenting a radiated appearance.

The internal medullary Root is shorter and broader than the preceding, and appears lost within and behind in the white substance, bounding the internal

part of the fissure of Sylvius, and is occasionally prolonged to the Corpus Callosum.

On raising the nerve from its grove, we observe the grey root which has the form of a pyramid lying on the junction of the other two roots, united to them by its apex, which is turned forwards: after this it may be traced along the superior surface of the nerve. If we cut the pyramid longitudinally, we expose a white substance in its centre, and three or four lines beyond its junction the greyish substance diminishes, leaving only the central white substance. We observe between the roots of the Olfactory Nerve a portion of medullary matter exposed at the lower part of the Cerebrum, and perforated with foramina for small arteries, so that the roots are encircled, and, as it were, pierced by these vessels.

The nerve becoming flatter and smaller, advances in approaching the middle line. It is lodged in a sulcus in the anterior lobe of the Brain. This sulcus extends farther forward than the nerve itself, and is

deeper in its middle part than at its extremities. The inferior surface of the nerve is marked by some longitudinal striæ, alternately grey and white. It has been a matter of much discussion, whether it is hollow or not. Sœmmering affirms, that it is hollow in the embryo of three months; Gall and Spurzheim that it is so even in the adult, and that air blown into its cavity will penetrate to the ventricles of the Brain, while Scarpa denies that it is hollow either in animals or man. The bulb of the Olfactory Nerve should be studied in very young subjects in whom the grey substance is transparent, and allows the arrangement of the medullary fibres to be seen. Scarpa advises you not to steep it in Monro's liquor, as this deprives the grey substance of its colour.

The first pair are distinguished from the other nerves of the Brain by the substances grey and white concurring to form their three roots, by their triangular form, their cerebral grove, their convergence, their being covered only on their inferior surface by

arachnoid membrane, their wanting a neurilemma, and leaving the Cranium by a number of foramina. I may here observe, that according to Gall and Spurzheim all the nerves are derived from the Medulla Oblongata, and Spinal Marrow: they observe: "The Olfactory is the only one we could suspect to be derived from the hemispheres of the Brain, but even in this case it is not the continuation of their white substance; it goes out of the grey substance collected in the lower surface of the hemispheres." They were not reckoned among the nerves at all by Galen or the older physicians. They considered them only as hollow appendices of the Brain, communicating with the Nose, and serving for the admission of odours, and the exit of fluids from the Brain; and it is only since the time of Willis they received the rank they now hold. Magendie has published a number of experiments to prove they are not the nerves subservient to the sense of smell, (See his Physiological Journal,) which, in his opinion, rather belongs to the fifth pair.

The second, or Optic Nerve, has been traced by Gall and Spurzheim to the anterior of the Tubercula Quadrugemina; from this it descends winding round the external part of the Optic Thalamus to which it adheres till it reaches a mass of cineritious matter on its inferior surface, termed the Corpus Geniculatum Externum; here it receives a reinforcement, and is continued in a broad and flatted form downwards, forwards, and inwards, under the name of the Tractus Opticus, till after curving under the Crus Cerebri (which is passing outwards and upward) it meets its fellow on the middle line forming the commissure of the Optic Nerves; here it is again reinforced by the tuber cinereum, or ganglion of the Optic Nerves, and ultimately enters the orbit.

The relation of these nerves to each other at their commissure, has been variously represented; some, as Galen, Zinn, Porterfield, Cloquet, &c., conceive there is a complete identification of their substance at this part. It has been urged in favour of this opinion, that in birds the Optic Nerve issues singly

from the Brain, and then divides into a right and left. Vesalius dissected a boy in whom they arose and terminated on the same side, and were perfectly distinct in their course; and he ascertained, that the boy was never affected during life with double vision, or any impediment in his sight. It has been thought a confirmation of this opinion, that the Thalamus has been frequently found diseased on the same side as the diseased Eye. Some anatomists reason in favour of their *complete* decussation from the analogy of fishes, in which they are seen to cross very distinctly, and from their having found the morbid appearances in the nerve, or Thalamus, of the opposite side when one of the Eyes was diseased. Others again suppose, that some of the fibres decussate, and that the rest are continued on to the retina of the same side. Dr. Wollaston assented to this opinion, in consequence of a nervous affection having occurred in his Eyes after great fatigue. This affection was a partial blindness: thus, in reading the name Johnson over a door he saw only the word *son*

whichever Eye he used. In this instance the blindness was on his left side; in a former case it was on his right side. Now he argues, that since corresponding points of the two Eyes sympathize, these corresponding points must be supplied with filaments from *the same nerve;* and the seat of the disease must be at a distance from the Eye in some place where these filaments are still united, perhaps in one of the Thalami. He admits, that in fishes the crossing is *complete;* but this, he says, is because in such case the Eyes are so placed back to back that they cannot both see the same object at once: but in man, he conceives, where both Eyes may receive impressions at once it is necessary to single vision that both sets of filaments should come from the same source. Gall and Spurzheim agree with those who "recognize a *partial decussation* of the Optic Nerves in man and the Mammalia: the fibres of the outermost portions appear to continue their course onwards without decussating." Treviranus hardened the commissure of the Optic Nerves in

alcohol, and found that a part of the fibres passed on from their origin to the retina of the same side, while those of the lower and internal portion appeared to *unite,* but could not be percieved to actually *cross.*

Now in examining these nerves you will invert the order in which I have described them, and trace them backwards from their commissure to their origin. You observe that the carotid arteries are placed one at either side of their junction; that anteriorly they are separated from the first pair of nerves by the anterior arteries of the Cerebrum; that farther back, where they are winding round the Crura Cerebri, they are not attached to them except by their anterior external margins; that they adhere to the Optic Thalami in passing round them; and lastly, you may observe that there descends from the posterior of the Tubercula Quadrugemina a little band on either side which cannot be traced beyond the Corpus Geniculatum Internum, and which, as already observed, some have suspected to be a root of the Olfactory Nerve.

Before these nerves make their appearance at the base of the Brain, they correspond on the inside to the Optic Thalamus and Crus Cerebri, on the outside to the middle lobe of the Brain, from which they are separated by the choroid plexus and arteries. After emerging from this fissure they are covered, on their inferior surface only, by Pia Mater and Arachnoid : after their junction they increase in size, and receive a neurilemma and arachnoid sheath ; lastly, on entering the orbit the arachnoid sheath is reflected, and their neurilemma is embraced by a fibrous canal. The different opinions as to their structure will be considered in speaking of the Eye. They are remarkable for their peculiar structure : their commissure, their central artery, their being accompanied by the Dura Mater to their termination, their circular contraction in entering the Eye, and their not giving off any branches in their course. Next to the fifth they are the largest of the cerebral nerves.

The inferior surface of *the Optic Thalamus* must be exposed in tracing this nerve. We saw the

superior surface in examining the lateral Ventricles: the internal surface we observed bounding the third or middle Ventricle, and united by the Commissura Mollis to that of the opposite side. The anterior extremity was found contributing to bound the foramen commune anterius: the posterior extremity was seen on opening the inferior Cornu of the lateral Ventricle, the external surface is continuous with the corpus stratun, and the inferior surface is now seen presenting two little greyish prominences towards its posterior part, these are the corpora geniculata externum and internum. These bodies (the Thalami) are supposed by Gall and Spurzheim to be Ganglions for reinforcing the Crura Cerebri as they are ascending to the hemispheres of the Cerebrum. Some anatomists describe a cavity in the interior of each, communicating with one in the Spinal Marrow: we will consider this matter more fully hereafter.

The third Nerve, or Motor Oculi, arises from a depression in the internal part of the Crus Cerebri, and may be traced to the dark substance in its interior

(the substantia nigra); it also receives filaments from that part of the floor of the third Ventricle, termed the locus perforatus. At its first appearance it is extremely soft and easily torn; the Fibres are ranged in a line parallel to the Crus itself;—the posterior are the longest. They unite to form a flatted Band that passes *backwards,* hooks round the posterior Artery of the cerebrum; comes out in front between this Artery and the superior of the Cerebellum. It then becomes smaller, rounder, and gets greater consistence; receives a neurilemma and arachnoid sheath, and passes outwards and forwards to a canal in the external wall of the Cavernous Sinus, at which it arrives in passing between the posterior clinoid process on the inside, and the concave margin of the tentorium on the outside.

The fourth Nerve (or Pathetic) comes from the anterior part of the valve of Vieussens, as already described, arising by Roots, varying in number from one to three, or even four. One Root is sometimes joined to a corresponding Root of the opposite side

by a transverse medullary Band, and Wrisberg has observed that the right nerve is often larger than the left. At its origin it is separated from the superior Artery of the Cerebellum by the superior Vermiform process, and from the posterior Artery of the Cerebrum by this process and the Tentorium; it then descends between the Cerebrum and Cerebellum, following the concave margin of the Tentorium, which receives it in a groove, accompanied by the two arteries just named. Finally, like the third Nerve, it enters a Canal in the outer wall of the Cavernous Sinus, at a point a little posterior and external to the latter. It is the smallest of the Cerebral Nerves.

The fifth Nerve may be seen emerging from the side of the Pons, in front of the Crus Cerebelli, (by which it is separated from the origin of the facial Nerve), and behind the Crus Cerebri, which separates it from the third Nerve. It consists of two portions; a smaller portion in front, which Mr. Charles Bell derives from the Crus Cerebri, and a larger portion behind, which he observes may be traced

through the Pons to the Corpora Restiformia. I may here observe, that Gall and Spurzheim describe it arising between the Olivary and Restiform Bodies. Bichat supposed that it arose from a tubercle at the side of the Pons, which may be exhibited by pulling the Nerve so as to break it. This appearance of a tubercle is now explained in the following manner. The central fibres of the posterior division of the Nerve receive their Neurilemma later than those at the circumference of this division, and when the Nerve is pulled, each fibre breaks exactly when it receives its Neurilemma.

The anterior internal Division, which arises from the Crus Cerebri, is situate above the remaining division, along the internal margin of which it may be traced as far as the Casserian Ganglion : it then passes under the Ganglion and leaves the Cranium by the foramen ovale, forming a part of the inferior maxillary nerve. This portion is smaller than the following, but consists of larger and softer filaments, five or six in number; they do not enter into the for-

mation of the Ganglion, and have no share in forming, by their rupture, the tubercle just spoken of.

The posterior external Division consists of a great number (seventy to eighty, or one hundred) of filaments, each of which is invested by a Neurilemma, that gives it more consistence and firmness. It forms, with the preceding division, a large flattened cord, and accompanies it in a direction upwards, forwards, and outwards, over the superior margin of the Petrous Bone, which it separates from the superior Petrosal Sinus, and terminates at length in the middle fossa of the Cranium, by forming *the Casserian Ganglion.* This Ganglion has a semilunar form ; its concave margin is turned backwards, and receives the posterior external, or greater division of the fifth Nerve : its anterior margin turned forward, gives off the Opthalmic, the superior, and the inferior maxillary Nerves. The first of these Nerves enters the outer wall of the Cavernous Sinus ; the second, larger and prismatic, goes out through the foramen rotundum ; the third and largest joins

the anterior internal division of the fifth, and with it forms the inferior Maxillary Nerve: the Ganglionic portion, according to Mr. Charles Bell, presides over the Sensation, and the non-Ganglionic portion over the Motion of the parts supplied. Finally, the Casserian Ganglion is placed between two layers of the Dura Mater, to which it adheres firmly, but is generally supposed not to supply it with filaments.

The sixth Nerve (or abductor oculi) is seen coming out of the groove between the posterior margin of the Pons and the corpus pyramidale, but may be traced (according to Gall and Spúrzheim) ascending along the side of the latter body. It passes forwards and outwards between the Pons and Cuneiform process of the occipital bone, separated from its fellow by the Basilar Artery; it is then received into a fibrous Canal of the Dura Mater, a little behind the posterior clinoid process. In all this course it was embraced by a Neurilemma and serous sheath, which latter is reflected soon after it enters the fibrous Canal.

The Seventh Nerve consists of two portions; the Portio dura, facial Nerve, or little Sympathetic, and the Portio mollis, or Auditory Nerve.

The Facial Nerve first appears in the groove between the Pons and corpus Restiforme; external to the sixth, anterior to the auditory, and superior to the Glosso Pharyngeal. This origin is soon joined by a distinct fasciculus of filaments, sometimes detached from the Auditory Nerve, and in other cases arising separately between the facial and the auditory. Sœmmering calls this fasciculus the *portio facialis minor.* The Facial Nerve is at first a white and flattened Cord, without Neurilemma, and adhering by its superior surface to the Crus Cerebelli: after communicating by the filaments just mentioned with the Auditory Nerve, it becomes free, and invested with a Neurilemma. It then takes a direction upwards, forwards, and outwards, lodged in a groove in the Auditory Nerve, from which it is separated by a branch of the superior Artery of the Cerebellum, that accompanies it into the internal auditory fora-

men. The exact origin of this Nerve has not been determined. Gall and Spurzheim have seen it in animals, ascending between the Olivary Body and Glosso pharyngeal Nerve.

The Auditory Nerve, or Portio mollis, is supposed to arise in the fourth Ventricle. Picolhomini conceived that the white transverse Striæ, observable in this cavity on the posterior surface of the corpora restiformia, were the roots of this Nerve; and the same opinion has been adopted by the Vic d'Azir, Scarpa, Cruickshanks, and Sœmmering. Many anatomists, however, among whom are Santorini, Prochaska, aud even Sœmmering himself, have observed that these Striæ were not always continuous with the roots of the Auditory Nerve, that they sometimes terminate in the Crura Cerebelli, and are occasionally wanting, for which reason it has been concluded that they are not essential to the origin of this Nerve. Gall and Spurzheim think that many filaments of the Auditory Nerve arise from the grey substance

found in the fourth Ventricle, of which I shall have occasion to speak more particularly hereafter.

The Auditory Nerve begins to separate from the Cerebral mass in a little triangular fossa, between the Pons, Crus Cerebelli, and Corpus Restiforme; in this same fossa we find the Facial Nerve separated from the Auditory by some small vessels, as already observed, and by a small process of the Spinal Marrow. This Nerve, at first soft and pulpy, soon divides into a number of Fibrillæ, like the other nerves, each covered by a Neurilemma. It is more consistent than the Olfactory Nerve, but softer than any of the rest. After becoming free it forms a flatted band, rolled, as it were, on itself, so as to form a groove on the inside for the Facial Nerve. It principally consists of filaments, frequently anastomizing together, except near the origin, where we often observe a soft, white band not filamentous. It communicates with the Facial Nerve by a kind of Plexus, aud then accompanies it upwards, forwards, and outwards to the internal Auditory Foramen, in passing under the

Crus Cerebelli, and on the inside of the lobular Appendix. This Appendix is like a little lobe placed in front of the Cerebellum, beneath the Crus Cerebelli, and on the outside of the Portio Mollis, round which it winds, accompanying it into the fourth ventricle.

The eighth Nerve consists of three divisions, viz. the Glosso Pharyngeal, Par Vagum, and Spinal Accessory. It is separated from the seventh by the lobular Appendix.

The Glosso Pharyngeal Nerve arises from the superior part of the Spinal Marrow, in the fissure that separates the olivary from the restiform body, below the facial Nerve, and above the par Vagum, from which latter it is separated by a portion of the circumference of the Cerebellum. Its filaments, varying in number from two to five, are sometimes separate, and sometimes united into one trunk. It is placed above and anterior to the Par Vagum, and passes forwards and outwards towards the posterior foramen lacerum, where it is received in a sheath of

the Dura Mater, anterior to, and distinct from that which incloses the two following portions.

The Par Vagum (or middle Sympathetic) arises immediately below the preceding, and in the same fissure, mostly by one, (but occasionally by two) ranges of filaments. These filaments are very numerous, and each about half an inch in length. They are firm, and from their origin, enveloped by Neurilemma. They unite at first into eight or ten more considerable fasciculi, which afterwards join to form a broad thin band, in composing which they run parallel without communicating. Surrounded by the Arachnoid Membrane they pass outwards and forwards, inferior to the glosso pharyngeal nerve, to arrive at the posterior foramen lacerum.

The Spinal Accessary Nerve arises from the side of the Spinal Marrow, by a range of filaments extending from a little beneath the Par Vagum, as far down as the posterior root of the fourth spinal Nerve; but the height of its lowest filament varies in different subjects: thus formed, it ascends into the Cranium,

behind the Ligamentum Dentatum, and Vertebral Artery, and between the anterior and posterior roots of the Spinal Nerves. After communicating in its course with the sub-occipital, and often with the first Cervical Nerve, it next takes a direction outwards and forwards, towards the posterior foramen lacerum, where it becomes engaged in the same canal of Dura Mater with the Par Vagum, beneath which it is placed, and only separated from it by the Arachnoid Membrane. Before its exit it sends a remarkable filament to the Par Vagum, and is often so adherent to it that both are taken for a single trunk.

The ninth, or Lingual Nerve, arises by ten or twelve very delicate filaments from the fissure which separates the Pyramidal and Olivary bodies. These filaments, each about a line above the succeeding, descend a little outwards, converging, and soon unite into one, sometimes two separate chords. They communicate frequently, and take a direction downwards and outwards behind the Vertebral Artery to the anterior condyloid Foramen. Sometimes

this Artery ascends between the fasciculi that compose the Nerve.

Having thus examined the surface of the base of the Brain, the course of the Arteries, and origins of the Nerves, our next object will be to give a short account of the converging fibres of the Cerebral Mass; and afterwards to examine the Medulla Oblongata from which the diverging Fibres take their principal origin.

The Converging Fibres of the Brain arise from the cortical substance that covers its surface, and terminate in two orders of Commissures;—one for the superior, and the other for the inferior Convolutions. These form, by their decussation with the diverging Filaments, a true and distinct tissue around the lateral Ventricles; in consequence of which, if we commence from the surfaces of the cavities we find a difficulty in unfolding the Convolutions till this tissue is destroyed, after which they may be separated by pressure of the fingers into two lamina, slightly agglutinated on the middle line.

After this decussation the Fibres of the superior Convolutions go out of the Hemispheres at their internal and inferior part, to terminate in the Corpus Callosum, or great Commissure. The converging Fibres of the inferior Convolutions of the anterior Lobe terminate in the anterior fold of the Corpus Callosum, and those of the posterior internal Convolutions will be found to terminate in its posterior fold. The anterior Commissure is formed by Fibres from the anterior Convolutions of the middle Lobe, and some Convolutions at the bottom of the fissure of Sylvius. The posterior Commissure could not be traced into the Convolutions, nor beyond the Optic Thalamus.

The Converging Fibres of the Cerebellum arise from the cineritious substance covering its laminæ, and pass between the diverging filaments (in directions varying according to their origins) towards the anterior and external parts of the Cerebellum to form its two Crura, and these unite on the middle line to constitute the Pons, or great Commissure of the Ce-

rebellum. As the Crura Cerebri diverge from the anterior part of the Pons, and the Crura Cerebelli from its posterior part, the four processes taken together have the form of a St. Andrew's cross. The Crura Cerebelli diverge more considerably than the Crura Cerebri; they likewise differ from the preceding, in diminishing in size as we trace them from the Pons, and they are formed of converging fibres while the Crura Cerebri consist of diverging fibres.

Each *Crus Cerebelli* is lodged in a horizontal groove in the front of the Cerebellum. Its posterior extremity emerges from the corresponding Hemisphere; its anterior extremity is united to the posterior angle of the Pons, and separates the fifth from the seventh Nerve, at their detachment from the Brain. Externally and inferiorly it corresponds to the lobular Appendix and seventh Nerve; internally, to the Restiform body and Processus ad Testes; and superiorly, to the Processus ad Testes and square lobe of the Cerebellum. Besides those that terminate in the Pons, Spurzheim describes other con-

verging fibres belonging to the Vermiform Process,* and derived one set from the superior, and the other from the inferior Velum.

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* There is much obscurity in those passages of Spurzheim's works that relate to this second Commissure. Most writers suppose him to say that the Vermiform process has a Commissure, consisting of the two Vela; the objections to this opinion will appear in the following, extracted from Dr. Gordon's work. "According to Drs. Gall and Spurzheim the principal part of the "Cerebellum, or in other words, the Vermiform Processes, are "provided with a Commissure as well as the other parts. Now "it will of itself, I imagine, strike most persons as somewhat ex-"traordinary, that a portion of the Cerebellum situated at this "primitive lobe is on the median Plane, and which is of course "single, should have any Commissure ascribed to it at all; for it "is understood to be the office of a Commissure to unite on the "median Plane two portions of the Brain exactly similar, which "are situated on the opposite sides of that Plane. But the parts "which are regarded as constituting this anomalous Commissure, "are no less remarkable. In paragraph forty of the Appendix

In this manner the converging fibres are traced to the different Commissures. As for the diverging filaments they principally arise from the Medulla

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" Drs. Gall and Spurzheim say, that ' it is formed of those soft " and thin laminæ of fibres belonging to the upper and lower por- " tions of the primitive part, which have been improperly denomi- " nated Valvules;' and from the passage of their large work, " which I have subjoined in the note, it would appear that by the " Valvules they understood those parts to which Reill has applied " the less exceptionable appellations of anterior and posterior " Vela. Now the anterior of these Vela, or the Vieusenian Valve, " we have already seen is entirely composed of longitudinal fibres, " placed parallel to the median line, and running from the su- " perior Vermiform process towards the Corpora Quadrigemina, " while the posterior Velum has a middle part also consisting of " longitudinal fibres, and two delicate lateral parts, of which the " minute structure has not been ascertained, but which stretch " outward until they unite with the subpeduncular Lobules, &c." Spurzheim has replied to Dr. Gordon's work, in a pamphlet published the same year, but I am not aware that he has noticed this

Oblongata, to the consideration of which I now proceed.

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objection. It has occurred to me that Spurzheim probably meant that the Vermiform process was a Commissure itself, in which the Fibres of the superior and inferior Vela terminated. And I think the following passage in his 'Physiognomical System' seems to support this opinion. "This Commissure is formed by the soft and fine fibrous layers *from* the superior and inferior parts of the fun damental portion, commonly called the superior and inferior Valves." Now I think if he had meant that these Valves were themselves the Commissure, he would have said the Commissure was formed by the soft and fibrous layers *of* the superior and inferior, &c. If this conjecture as to Spurzheim's meaning be correct, he will be found to agree with Reill as to the inferior Velum, for this latter author makes its lateral fibres terminate on the middle line in the inferior Vermiform process. And as to the superior Valve, Spurzheim appears to include both the Processus ad Testes and Valve of Vieussons under this denomination, and Reill in some parts of his book employs the appellation 'superior Velum' in the same extended sense.

The term *Medulla Oblongata* has been employed by different writers in different senses. Boyer and Portal include under this denomination the Pons, head of the Spinal Marrow, Crura Cerebelli, Crura Cerebri, and Corpora Albicantia; Haller confined the name to that part that others have termed the head of the Spinal Marrow; and in this he has been followed by most modern anatomists, as Reil, Spurzheim, Gall, Gordon, and Bell. According to this view, the Medulla Oblongata commences at the posterior margin of the Pons, and extends downwards and backwards to terminate opposite the margin of the Foramen Magnum. Its sides correspond anteriorly to the vertebral Arteries, and give origin to the eighth and ninth pair of Nerves; its anterior inferior surface is separated from the Cuneiform Process of the Occipital bone, by the Vertebral and anterior spinal Arteries. Its posterior superior surface supports the Cerebellum and valve of Vieussens, and presents the appearances to be described in examining the fourth Ventricle, of which it forms

the anterior wall. The anterior surface presents on the middle line a longitudinal Fissure, separating two medullary cords that are termed the *Corpora Pyramidalia;* and external to these latter are the *Corpora Olivaria.*

The Restiform Bodies are two slender oblong cords that may be observed diverging as they ascend on the posterior surface of the Medulla Oblongata. If we examine the manner in which these bodies terminate inferiorly, we will find that the Pyramidal and Restiform bodies are continuous with the anterior and posterior spinal cords, and that the Olivary terminate in a pointed form between them, being each of them not more than half an inch in length.

The Olivary Body contains in its interior a greyish oblong Ganglion, surrounded by the white rind seen on the exterior. It may be exhibited by a transverse section, after the exterior has been examined. It will then appear circumscribed, and separated from the white rind by a yellow waving line. This Gan-

glion is usually called the Dendroid body; but it has a multitude of other names, as the rhomboid, dentated, serrated, festooned, zigzag, &c. which being also applied to the Ganglion of the Cerebellum, is likely to produce much confusion. It may be exposed after the exterior of the Cerebellum has been examined. Besides these three bodies observable on the Medulla Oblongata, Mr. Charles Bell describes a fourth. Speaking of the respiratory Nerves, he observes, "Their origins are not in a bundle or fasciculus, but in a line or series, and from a distinct column of the Spinal Marrow. Behind the Corpus Olivare, and anterior to that process that descends from the Cerebellum, (the Corpus Restiforme,) a convex strip of Medullary matter may be observed; and this convexity, or Fasciculus, or Virga, may be traced down the Spinal Marrow between the Sulci, which give rise to the anterior and posterior roots of the Spinal Nerves. This portion of medullary matter is narrow above where the Pons Varolii overhangs it. It expands as it descends; opposite the

lowest part of the Corpus Olivare it has reached its utmost convexity, after which it contracts a little, and is continued down the lateral part of the Spinal Marrow. From this track of medullary matter on the side of the Medulla Oblongata, arise in succession from above, downwards, the portio dura of the seventh Nerve, the Glasso Pharyngeus Nerve, the Nerve of the Par Vagum, the Nervus ad par vagum accessorius, the Phrenic and external Respiratory Nerve." By this last he means the posterior Thoracic Nerve that supplies the serratus magnus muscle.

Let us now trace each of these portions of the Medulla Oblongata upwards, and we will find that they form, by their irradiation, the diverging fibres of the Cerebrum and Cerebellum.

First, the Restiformia may be observed ascending at the posterior part of the Medulla Oblongata, on the inside of the Crura Cerebelli: they increase in size in their progress, and afterwards bending backwards, each over a groove in the superior surface of

the almond lobule, they penetrate the Cerebellum, where after a course of a few lines they enter the Corpus Dentatum, or great Ganglion of the Cerebellum. The Fibres form with this so firm a tissue that it is impossible to distinguish their direction. The fasciculi that go out of the Ganglion continue their course in a radiated manner. Each of them appears to arise from one of the teeth or projections of the Corpus Dentatum. One of the most remarkable of these Fasciculi proceeds towards the middle line, and with the corresponding Faciculus of the opposite side, forms the fundamental part of the Cerebellum, or Processus Vermiformis. The other Fasciculi ramify backwards, upwards, downwards, and outwards, expanding into delicate laminæ, placed horizontally. Those branches arising from the posterior part of the Ganglion are longest. The others are shorter the nearer they are to the place where the Corpus Restiform enters the Ganglion. Finally, the extremities of these laminæ most distant from the Ganglion are covered, as well as the Vermiform

Process by the grey substance. These Restiform bodies are called the Processus ad Medullam Oblongatam, or inferior Peduncles of the Cerebellum, for according to the old mode of describing these parts, the Cerebellum was said to send three pair of prolongations to the adjacent parts: one pair entered to the Spinal Marrow, constituting these inferior Peduncles; another pair to the Pons, forming the lateral Peduncles, Processus ad Pontem, Crura Cerebelli, &c. and a third pair to the Testes, forming the superior Peduncles, or Processus ad Testes.

The next Prolongations of the Medulla Oblongata to be traced, are those of the Olivary and Pyramidal bodies: these are continued upwards and forwards through the Pons, with the transverse fibres of which *their* longitudinal fibres alternate. Thus the Pons presents on the surface a transverse stratum of fibres, and if this be divided from before backwards, we come on a stratum of longitudinal fibres, formed by the pyramidal bodies: the next stratum is another layer of the transverse fibres of the Pons; the fourth

stratum consists of the longitudinal fibres of the Olivary bodies; the fifth forms the posterior surface of the Pons and floor of the aqueduct of Sylvius: its fibres are oblique, and not very distinct. Now in the interior of the Pons there is distributed a quantity of grey matter, by which the Pyramidal and Olivary bodies are supplied with additional filaments; consequently, when they emerge at the anterior part of the Pons, under the name of the Crura Cerebri, they are increased in size.

Each *Crus Cerebri* will be found to consist of an anterior external portion, continued from the Pyramidal body; and a posterior internal portion continuous with the Olivary, and part of the Restiform body: they may be separated by the blowpipe, or a stream of water. The former of these constitutes at least two-thirds of the Crus: it increases in size considerably more than the posterior internal portion, and its principal augmentation occurs at its upper extremity, where it is attached to the optic nerve. The faciculi composing each of these two

portions are separated by a quantity of grey matter, which presents, when the Crus Cerebri is divided transversely, a dark semilunar spot, termed the *substantia nigra.* The anterior extremity of the Crus Cerebri plunges into the Hemisphere; the posterior extremity emerges from one of the anterior angles of the Pons, separating the third and fifth Nerves at their detachment from the Brain; superiorly it is connected to the tubercula quadrugemina by its posterior internal portion; and inferiorly it corresponds to the Crus Cerebri, superior artery of the Cerebellum, posterior artery of the Cerebrum, and fourth pair of Nerves.

After the anterior external or pyramidal faciculus has passed over the tractus Opticus, on its way to the Hemisphere of the Brain, its filaments separate, and form laminæ that compose the anterior, external, and inferior convolutions of the anterior and middle lobes of the Brain. The Olivary Faciculus passes successively through the Optic Thalamus and Corpus Striatum, in each of which Ganglions it is reinforced with additional filaments by the grey matter in their

interior, and expands into the layers that form the Convolutions of the posterior lobes, and the superior and internal convolutions of the anterior and middle lobes. In this manner Gall and Spurzheim trace the diverging filaments of the Brain and Cerebellum from the Medulla Oblongata, and from the grey matter distributed in the form of Ganglions through the Cerebral mass. Spurzheim suggests the enquiry whether the converging and diverging Fibres may not be continuous by their peripheral extremities, but has not been able to determine this point.

The termination of Mr. Bell's fourth faciculus of the Medulla Oblongata I shall describe in his own words:—" The column of Medullary matter which constitutes that part of the Medulla Oblongata, from which the respiratory Nerves arise, terminates upwards, or at its anterior extremity, just under the corpora quadrigemina, and there the fourth Nerve arises."—p. 296, 1823.

It is a fact that has been known to every Pathologist, since the days of Hippocrates, that pressure on

one hemisphere of the Brain generally produces Paralysis on the opposite side of the body. This circumstance was attributed by Aretæus, and many subsequent Anatomists, to a mutual crossing of the Cerebral Nerves in the Encephalon. At present it is explained by the mutual decussation of the pyramidal bodies—an Anatomical fact that was first pointed out by Mistichelli, and afterwards noticed successively by Petit, Lieutand, Santorini, and Winslowe. It has received the fullest confirmation from the observations of Gall and Spurzheim, the latter of whom describes it in the following words:—"Just at the spot," says Spurzheim, "where the Medulla Oblongata, or great Occipital enlargement begins to swell at its lower part, at one inch and a few lines below the Pons Varolii, let the Arachnoid and vascular coats be divided by a superficial incision, not extending into the subjacent parts, and then be carefully removed. If then the edges of the groove which runs in the middle line be gently separated, there are seen three, four, or five threads

crossing each other, coming obliquely from below upwards, and occupying a space of about three or four lines in length. The nervous threads arising in the cortical substance on each side pass respectively to the opposite side, so as to produce a decussation of the pyramids. These primitive threads of the pyramids vary in number and size; there are five, four, or three, and sometimes the primitive fibres instead of forming an inter texture of this kind, presents bands which pass obliquely to the side opposite to that from which each comes. The decussation is constant, but the form and size of the crossing fibres vary."

It has been observed, that occasionally the paralytic effects appeared on the same side of the body as injury: in this case, Spurzheim supposes that the part injured was formed by the Olivary Faciculi, which do not decussate.

This explanation, however, is not satisfactory; for the Restiform bodies do not decussate, and yet when one of the Hemispheres of the Cerebellum is in-

jured, it appears from the cases recorded by Bianchi, and other authors referred to in Portal's Anatomy, that the paralysis occurs on the opposite side. Lorry's experiments on pigeons proves that this rule extends also to the Medulla Oblongata; and the case recorded by Dr. Yellowly proves the same as to the Pons Varolii. The Spinal Marrow is, therefore, the only instance of the Cerebral mass producing Paralysis on the same side of the body: we derive our knowledge of this from the experiments of Galen and those of Sir A. Cooper.

While the cavity of the fourth Ventricle is exposed, I would wish to direct your attention to *the inferior Medullary Velum.* Having drawn the head of the Spinal Marrow forwards, and also drawing *very gently* the hemispheres of the Cerebellum outwards, you will see in the fourth Ventricle two semilunar Laminæ, extending transversely between the anterior extremity of the Vermiform process on the inside, and the little lobular appendix which you might have observed (under the Crus Cerebelli, and on the

outside of the seventh pair of Nerves) even before opening the Ventricle. These Laminæ are called *the wings* of the inferior Medullary Velum ; between the wings within the Ventricles, and in front of the inferior Vermiform Process, is *the body* of the inferior Velum. Each wing is a semilunar Medullary Lamina, the external extremity of which is on the outside of the Ventricle, and attached to the lobular appendix; the internal extremity placed within this cavity is directed forwards, and bifurcated into an anterior and posterior portion: the anterior portion is continuous with the body of this Velum, and the posterior portion penetrates into the interior of the Vermiform Process, where it is lost. The concave margin of the wing is free and turned forwards; this concave margin embraces the hollow angle formed by the Corpus Restiforme, turning backwards to enter the Cerebellum. The convex margin of the wing is turned backwards, and attached externally to the Almond Lobule, internally to the side of the Vermiform Process, and between these parts to a transverse

band that connects them ; the superior surface of the wing supports the reflected portion of the Corpus Restiforme, but does not adhere to it: a space is therefore left between them, bounded on the inside by the Vermiform Process, and closed posteriorly by the attachment of the convex margin of the wing. The inferior surface rests on the Almond Lobule. Reill conceives that the Lobular appendices are imperfect lobes, and that the inferior Velum serves as a kind of commissure between them. The Lobular Appendices have many other names;—thus, Reill terms them the Flocks, Vic d'Azir the Lobules of the Par Vagum, and Dr. Gordon the subpeduncular Lobules.

If you examine the boundaries of the fourth Ventricle, you will find that its *anterior wall* is formed by the posterior surface of the Medulla Oblongata, which is inclined downwards and backwards—that on this same surface rest the Medullary Processes that form *the sides* of the Ventricle, viz. the Processus ad Testes above, and the Corpora Restiformia in-

inferiorly; the former bodies diverge as they descend, and the latter as they ascend to meet them, (after which both pair enter the Cerebellum on the inside of the Crura Cerebelli): from this account it follows, that these processes circumscribe a lozenge shaped space, and in this space we find a quantity of grey substance. *The Roof* is formed by the superior Medullary Velum, or Valve of Vieussens, which in this situation is directed horizontally backwards. In front, the roof is in contact with the anterior wall, but posteriorly they are separated by the tubercle, termed the body of the inferior Medullary Velum: this tubercle, as already observed, is placed before the anterior extremity of the inferior Vermiform Process which forms the *posterior wall* of the Ventricle. *The anterior superior extremity* of this cavity communicates by a small opening with the aqueduct of Sylvius, and *the posterior inferior extremity* is closed by a firm membrane, extending from the inferior Vermiform Process to the head of the Spinal Marrow.

The parts observable on the anterior wall are, *first*, a longitudinal depression on the middle line, termed the *Calamus Scriptorius;* this terminates inferiorly in a little pore, or Foramen, which is the commencement of the central canal of the Spinal Marrow. *Secondly*, we observe the grey substance already spoken of, but very small in quantity. Gall and Spurzheim observe that " the grey substance of the fourth Ventricle is in smaller quantity in man than in animals. In the sheep, hog, horse, and ox it has the bulk of a pea. It is consequently a real dilatation origin, or *Ganglion of the Auditory Nerve*, which here receives its greatest reinforcement. This Ganglion is placed precisely at the point where the Auditory Nerve turns round the Corpus Restiforme, and its size is always proportioned to that of the Nerve." *Thirdly*, you may observe delicate white lines passing upwards and outwards from the Calamus Scriptorius. They vary much in their number and direction, and they are sometimes not perceptible. The superior *generally* go to the roots of the

Auditory Nerve, and the inferior to the Cerebellum.

Besides these appearances on the anterior inferior wall, we generally find in the fourth Ventricle a little choroid Plexus, consisting of three portions: the middle portion projects into the Ventricle while the lateral portions are rounder and smaller, and are found in the fissure that separates the Cerebellum from the Mesocephale.

The superior surface of the Cerebellum has been examined at page 46, to which the reader may refer if he desire a continuous account of this part. We now proceed to examine *the inferior surface of the Cerebellnm.*

This presents on the middle line a depression, separating the Hemisphere and receiving the head of the Spinal Marrow in front, and the lesser falx of the Dura Mater behind. The posterior part of the Valley (for so Haller terms this depression) is divided into two portions parallel to each other, by the inferior Vermiform Process. To expose this process,

you should carefully separate the Hemispheres of the Cerebellum, and draw forward the head of the Spinal Marrow. *The inferior Vermiform Process* has somewhat of a crucial form, consisting of a transverse and longitudinal Ramus. The former of these is very short, and formed by the broadest part of the Process. Its arms, or lateral portions, stretch a little forwards, and join the Apices of the Digastric, or Cuneiform Lobules; the longitudinal Ramus consists of a long narrow portion in front of the transverse Ramus, and a shorter and flatter portion behind it. The anterior portion, usually called the *Luette,* is salient, and flat on the sides, corresponding by its anterior extremity to the body of the inferior Velum; the portion behind the transverse Ramus is flat, and not very prominent; the entire of the inferior Vermiform Process consists of a number of transverse Lamellæ, varying in length, thickness, and prominence; its anterior extremity is separated from the superior Vermiform Process by the valve of Vieussens; posteriorly their extremities are

separated by a transverse Lamella, that Reill terms *the slender Commissure.* If we look into the fissure that separates the transverse from the posterior part of the longitudinal Ramus, we will observe a secondary Lamella, which Reill terms *the concealed Commissure;* and the whole of the parts on the middle line, viz. the superior and inferior Vermiform Processes, he calls *the General Commissure.*

The inferior surface of each Hemisphere consists, first, of an anterior portion, flat, and corresponding to the posterior surface of the Petrous Bone; secondly, of a posterior portion, convex, and lodged in the inferior occipital Fossa. There are generally enumerated on each side four lobules; there will be five if you include the lobular Appendix: omitting this last, the first lobule (*Almond Lobe* of Reill and Meckel) is found beside the Head of the Spinal Marrow; it is round and convex, elevated in the centre, and consists of a number of concentric Lamellæ, which often differ from those of the other Lobules, in having their concavities turned outwards and backwards.

This Lobule presents on its superior surface a depression for the Corpus Restiforme. It is connected to its fellow of the opposite side by the inferior Medullary Velum. Secondly, this Lobule is received into the concavity of the *Cuneiform* or *Digastric* Lobule, which is broad in front where it commences under the Crus Cerebelli, and behind the Lobular Appendix; from this it diminishes in breadth as it passes first backwards, and then inwards towards the middle line, where its Apex is joined, as already described, to the transverse Ramus of the inferior Vermiform Process. Thirdly, behind and external to this, there is a *slender Lobule* embracing the preceding by its concavity, and embraced behind by the last or *posterior inferior Lobule*. The inferior surface of the Cerebellum is separated from the superior—in front by a transverse margin, *the centre of which* is semilunar from side to side; posteriorly and laterally by a margin that is convex *in its whole course*. The posterior margin is divided into a right and left portion by a *vertical* fissure, for receiving the lesser

Falx; and into a superior and inferior lip by a *horizontal* fissure: this last changes as you trace it round the circumference from a mere fissure into a deep horizontal channel for lodging the crura Cerebelli, but it is then part of the anterior margin. The anterior margin extends from the base of the Petrous bone on one side, to a similar point on the opposite side: its thickness or vertical depth is very considerable when compared with that of the posterior margin. Its central part presents a notch semilunar from side to side, this embraces the tubercula quadrugemina, processus ad testes, and valve of Vicussens; at each side of the notch the anterior margin presents a horizontal channel (as already observed) for the Crus Cerebelli as it passes forwards and inwards to meet its fellow, and form the Pons.

You may now expose the interior of the Cerebellum by incisions through it in different directions: a vertical incision exposes the appearance termed *Arbor Vitæ,* from its supposed resemblance to the Thuya, or tree of life. If the vertical incision be

made through the middle line, we will expose seven principal ramifications of white substance. The *Corpus Dentatum* is exposed by dividing vertically one of the hemispheres, so as to leave two-thirds externally, and one-third internally. If this Ganglion be divided through its centre, eleven principal branches are exhibited: it is placed nearer to the anterior than the posterior part of the Cerebellum; a transverse section of the Cerebellum shows it in its greatest extent, and also shows an excess of the white above the grey substance, whereas in the vertical cuts, the grey appears to predominate over the white.

THE SPINAL MARROW.

The Spinal Dura Mater forms a funnel-shaped membranous canal, a transverse section of which would present nearly a circular appearance, while a

similar section of the bony canal would present that of a triangle, except in the dorsal region. This membrane does not fill the canal that incloses it, and therefore cannot serve for periosteum, as in the Cranium. Within the Dura Mater the Spinal Marrow is contained, invested by a proper membrane, or Pia Mater, that is loosely covered on its exterior by the Arachnoid Membrane. The exterior of the Dura Mater is connected to the Spinal Canal by a loose reddish cellulo-filamentary tissue, except in front, where it has a tolerably well marked adhesion to the posterior vertebral ligament. This tissue does not contain fat in the greatest part of its extent, but below, near the Sacrum, some is usually met with. In this situation the cellular tissue is more abundant than in any other part of the canal.

The Dura Mater forms on its sides little fibrous canals for the Nerves that pass through it. These in the cervical region are very short, and nearly transverse; but in the dorsal and lumbar regions their length gradually increases, and they become

successively more oblique, and at length nearly vertical; in the same way those above are of small volume, but they gradually increase as the nerves they contain: in passing through the spinal foramina they very suddenly and sensibly dilate, in order to accommodate the Ganglions formed by the posterior roots of the Nerves; they are ultimately lost in the cellular tissue without the Spinal Canal, and not continuous with the Periosteum like the Cranial Dura Mater. This fibrous canal does not every where present the same volume, but varies as the Spinal Marrow, which we will describe just now. We may now slit up the Dura Mater and examine its internal surface, this we observe is lined by the Arachnoid Membrane, which gives it a glossy appearance; the nerves may be seen passing through the foramina in its side, and between each pair is attached a pointed process of the Ligamentum Dentatum. If you examine the manner of connexion between these, you will find the process of the ligament is received into a small opening in the

Dura Mater before being identified with it; to see this you should dissect the Arachnoid from one or two of them. The Spinal Dura Mater is continuous with the Cranial at the Foramen Magnum, to which it adheres firmly; immediately below this it presents an opening for the Vertebral Artery and sub-occipital Nerves; inferiorly it terminates in forming five fibrous filaments that are attached to the Sacrum and Coccyx. In all this region the Dura Mater presents the same structure as in the Cranium; its fibres, however, are less distinct, but more regularly arranged than in the latter situation—their direction is mostly longitudinal; the plane they form has less thickness, and this diminishes the lower down they are examined. According to Boyer, it consists of two Laminæ, the internal is truly perforated by the Nerves, but the edges of the openings in the external are continued on the Nerves forming the fibrous sheaths already spoken of. It receives its Arteries from the vertebral, intercostal, lumbar, and lateral sacral. Its veins open into the Vertebral

Sinuses, to be examined just now. As for Nerves none have been discovered, except those that accompany the Arteries.

The Ligamentum Dentatum appears to belong to the fibrous tissue; it extends from the Foramen Magnum to the inferior extremity of the Spinal Marrow, under the form of a long, white, firm, transparent band; it occupies the triangular interval which the Spinal Marrow forms with the anterior and posterior roots of the Nerves, being nearer the former than the latter roots. Its internal margin is united to the Pia Mater, or proper Membrane of the Spinal Marrow, by a dense cellular substance; it may, however, be dissected off, and shown not be a part of this Membrane, as some Anatomists supposed: its external margin presents a number of little prolongations, that are united to the Dura Mater; these become as they pass outward rounder and narrower, but extremely dense and resisting; each of them corresponds to an interval between two Spinal Nerves: they are very short above, but increase in length as

they are traced downwards; between them the margin of the ligament is concave. Internally this ligament is thin, externally it is thicker, both in the prolongations and their intervals; it is covered by the Arachnoid passing from the Pia Mater to the Dura Mater: above its posterior surface corresponds to the Spinal Accessory Nerve. The insertion of its first process is into the edge of the Foramen Magnum, separating the Lingual Nerve from the Vertebral Artery. Its last process usually separates the Dorsal from the Lumbar Nerves. The number of processes is generally twenty-two, but there may be more or less.

The Arachnoid that covered the Brain is prolonged downwards over the Spinal Marrow and its proper Membrane, or Pia Mater. It is not, however, closely connected to this last Membrane (the Pia Mater) as in most parts of the Brain, it is only attached by cellular filaments that are easily broken and sometimes scarcely exist at all. If you force air between them with a blow pipe you will readily separate

them, and often distend the Arachnoid through its whole length into a capacious tube, owing to the expansion of the sheaths that it sends round the nerves. Each of these serous sheaths is conical in its form, and having reached the Dura Mater is continuous with its Arachnoid lining; the best way of seeing this continuity or reflection of the Arachnoid is to cut across the fibrous sheath close and external to the Dura Mater, you will then see the disposition of the Arachnoid on the inside. Besides these the Arachnoid forms similar sheaths for the vessels, the ligamentum dentatum, and its processes; inferiorly the Arachnoid forms sheaths for the terminating fasciculi of the Spinal Marrow, which are reflected as above described; the Arachnoid in this manner forms a cul de sac, which prevents the serous effusions frequently found there from infiltrating into the cellular tissue.

We may slit up this Membrane now, having first made a small opening into it, and detached it by the blow pipe. You thus bring into view the pos-

terior Spinal Arteries: each of these usually comes from the Vertebral, but may come from the Basilar or from the inferior Artery of the Cerebellum: it passes downward and a little obliquely inward to get behind the Spinal Marrow, where it may be traced parallel to its fellow as far as the second lumbar Vertebra. It is extremely slender; all its branches are transverse and anastamose with those of the opposite side, or are lost in the Pia Mater, except a few capillary branches that enter the substance of the Spinal Marrow.

The Pia Mater of the Spinal Marrow is continuous with that of the Brain, but differs from it very much in its structure. In the Cranium it is merely a cellular basis for the ramification of vessels, but in the Vertebral canal it is solid, thick, resisting, and somewhat fibrous. You may examine it in either of the ways that Bichat employed: first, you may cut it longitudinally, and scoop out the Medullary substance; or you may make a transverse section near the Foramen Magnum, and press it out between

your fingers, so as to form a long hollow cylinder that may be inflated, or even injected. Its external surface corresponds to the Arachnoid Membrane, from which it is separated in front and behind by the Spinal Arteries; on its sides it is continuous with the Neurilemma of the Nerves, and gives attachment through the medium of dense cellular substance to the Ligamentum Dentatum, which, however, is no part of it, as some anatomists suppose: others have confounded this ligament with the serous Membrane that covered it. Its internal surface corresponds to the Spinal Marrow and sinks into its fissures, forming an intimate connexion with it by its vessels and processes. It may, however, be separated from it, and then the Membrane loses much of its dense appearance. It seems to be formed of distinct fibres, particularly on the sides. Its density increases as you trace it downwards, and it is to this the greater firmness of the Spinal Marrow in its lower than in its upper part is owing: very few vessels are lost in its tissue, but a great number ramify in its substance

previously to entering the Spinal Marrow. Its colour is pale yellow, a tinge which it gives to the Spinal Marrow as seen through; but on splitting it up you find the latter much whiter. Its use is to sustain and gently compress (Majendie) the Spinal Marrow, to which it has the same relation as the Neurilemma (with which it is continuous) has to the Nerves. The change in the nature of the Pia Mater of the Spinal Marrow from that of the Brain is not abrupt; the latter becomes gradually stronger over the Pons, Corpora Pyramydalia, &c. till it terminates in the strong Membrane of the Spinal Marrow.

The Spinal Marrow extends from the posterior edge of the Pons to the first or second lumbar Vertebra. It consists of a head, a body, and a tail. This head is the Medulla Oblongata of Haller, and has been already described: it extends from the posterior edge of the Pons to the margin of the Foramen Magnum. The body extends to the last dorsal Vertebra, and the remainder is the tail. You ob-

serve that the Spinal Marrow does not fill the bony or even the fibrous canal that contains it; that its size varies in different parts, but is always proportioned to the size of the Nerves it gives off. Large at its upper extremity it becomes smaller in the middle of the neck; it enlarges again at the lower part of the cervical and upper part of the Dorsal Region; it is smaller in the middle of the Dorsal Region, but enlarges at its lower part to give off the lumbar Plexus; it diminishes inferiorly, and terminates by two tubercles, the superior, large and ovoid, the inferior, smaller and conical. Placed at equal distance from the roots of the transverse processes to which its sides correspond, it is nevertheless nearer to the anterior than the posterior wall of the bony canal. It follows the curvatures of the spine, and is flattened from before backwards; this is less observable in the dorsal than in either of the other regions; like the Brain it is enveloped by three Membranes, that have been just described. It is steadily maintained in its place by the dentated ligament, the

the Nerves, their sheaths, and the blood-vessels that repair to its proper Membrane. It also owes its security in a great measure to its admitting of elongation, and shortening through the medium of transverse grooves that are observable over its whole surface, particularly the anterior part, between the last cervical and ninth dorsal Vertebræ. To see this property distinctly, Chaussier recommends you to take out the Spinal Marrow, place it on the table, and gently push its extremities towards each other.

The Spinal Marrow is cut longitudinally by six fissures, viz. one in front, one behind, and two on each side. Those on the middle line are called the median fissures, and those on the sides are called the collateral fissures.

The posterior Median Fissure is more deep, but less evident than the anterior; we perceive at the bottom of each a layer of white matter: this in the posterior fissure is formed by two longitudinal fasciculi which descend, forming a Raphè on the middle line like that of the corpus callosum; but in the

anterior fissure, as we will find just now, the fibres are transverse and indigitate with each other on the middle line, but do not cross to the opposite side.

The Collateral Fissures are those longitudinal grooves in which we see the anterior and posterior roots of the Nerves arising. They commence at the Medulla Oblongata, one before, and the other behind the Olivary Body, from this they may be traced down as far as the ninth dorsal Vertebra; the posterior are better marked than the anterior, being about half a line in breadth, and presenting at the bottom of each a reddish substance, of a soft consistence; the anterior are not so well marked, and the substance at the bottom is not of so deep a colour, but is of a firmer consistence.

The posterior roots of the Nerves are larger than the anterior, from which they are separated below by the Ligamentum Dentatum, and above by the Accessory Nerve and this Ligament. The origins of the Spinal Nerves are best traced in a young child, by striping off the Membranefrom the Spinal

Marrow; they are more readily seen in the posterior or cervical region than elsewhere. When you pull the Nervous filaments that form the ro ots, thesepa-rated extremity presents the appearance of a kind of bulb, of greyish substance, and flocculent, and the Spinal Marrow exhibits so many little holes. There are thirty pair of Spinal Nerves, seven Cervical, twelve Dorsal, five Lumbar, and six Sacral; they are thus classed by Willis, Vieussens, Winslow, Sa-batier, and Bichat. The last author gives the fol-lowing reasons for not including the sub-occipital: first, it is much smaller than the Spinal Nerves; se-condly, the posterior root is often wanting, or when present, is not on the same line with the correspond-ing roots of these Nerves; thirdly, the anterior is larger than the posterior, the reverse of what we find in the Spinal Nerves; fourthly, its distribution is less extensive; fifthly, it concurs but little to the Cervical Plexus, of which the other Cervical Nerves form an essential part. Many, however, reckon eight Cervical Nerves, among whom are Santorini,

Heister, Haller, Asch, Sœmmering, Boyer, Portal, Chaussier, Marjolin, Gall, and Bell: the sub-occipital and first spinal go out behind articular processes of the Vertebræ; all the rest go out before them. Each of the roots has a fibrous canal furnished it by the Dura Mater, and each of the posterior roots forms in its canal a greyish, oval, and rather dense Ganglion. The fasciculi proceeding from this become united to the anterior root, so as to form but one trunk, from which it divides into two branches, of which the anterior is larger than the posterior, except in the first cervical. The first and second Nerves alone go out of the canal in a horizontal direction, all the rest descend with an obliquity and length increasing as we trace them downwards; those that are lowest are nearly vertical, they form the cauda equina which surrounds and conceals the tubercle that terminates the Spinal Marrow inferiorly.

The filaments that form the sub-occipital Nerve, from eight to nine in number, unite into two or three

fasciculi, and separate, in the greatest number of subjects, from the anterior part only of the Spinal column; sometimes, however, it is joined by a smaller fasciculus from the posterior column that arises somewhat lower down; they are generally separated by the Spinal Accessory Nerve, which, however, sometimes ascends behind its posterior root, and sends a communicating branch to the anterior. Thus formed, the nerve passes backwards and outwards, perforates the Dura Mater, and is placed between the Vertebral artery and the groove in the posterior arch of the Atlas, when it forms an elongated Ganglion, and divides into two branches, an anterior and posterior.

The Spinal Accessory Nerve arises from the side and posterior part of the Spinal Marrow, as described at page 95, then entering the Cranium, behind the Vertebral artery, it attaches itself to the Par Vagum, from which it is separated by the inferior artery of the Cerebellum. If one arises higher than its fellow, it will be proportionally larger; it often

communicates with the first pair of Nerves, and constantly with the anterior branch of the sub-occipital; in this region, as observed by Huber, Sabatier, and Portal, the Spinal Accessary forms a little Ganglion; some deny its existence, as Asch, Lobstein, Haller, Sœmmering, Gall, Spurzheim, and Cloquet; I have in some cases seen it. You should now remove the Spinal Marrow from its bony canal and examine its anterior surface.

The *Anterior Spinal Artery* arises from the Vertebral, near its termination; sometimes from the inferior artery of the Cerebellum, or even from the Basilar trunk. It descends in a tortuous manner, and unites with its fellow, opposite the foramen magnum, so as to form a single trunk larger than either of the posterior Spinal Arteries: this descends in a tortuous manner in front of the Spinal Marrow, below which it is prolonged, without dividing, till it reaches the sacro coccygean articulation, and here it terminates in anastamozing with the lateral sacral arteries. In this course it gives off branches, in every respect analogous to those of the posterior Spinal.

You may now examine the transverse furrows on this part of the Spinal Marrow. Spurzheim finding that they entirely disappear when the Spinal Marrow is stretched, infers from this that they depend on the bending of the cord, and not on any original peculiarity of organization. Look now into the anterior median fissure and you will observe filaments running transversely towards the middle line, forming bundles, each of which terminates between two of the opposite side.

As to the structure of the Spinal Marrow, you will find it differ remarkably from the Cerebrum, in its white substance being placed exteriorly, and its grey substance internally. Its consistence in the adult is generally less dense than that of the Pons, but more than that of the Cerebrum and Cerebellum. In children its consistence is much firmer, and Chaussier observes, that in women its softness is very remarkable.

The exterior of the Spinal Marrow is formed of medullary matter, arranged in two longitudinal

bands, like pieces of tape, which are separated from each other in front and behind by the anterior and posterior median fissures. Each of these bands is about half a line in thickness: on its external surface it is convex, subdivided according to its length into three narrow slips by the two collateral fissures, and applied to the Pia Mater: its internal surface is applied to what is termed the Commissure of the Spinal Marrow. The Commissure of the Spinal Marrow should be examined in a child newly born. "You are to strip off," says Chaussier, "its tunic, to place two fingers on one side of the Median Fissure, and with the other hand draw away gently the opposite side of the spinal Marrow. The Commissure will remain attached to one side, and will present a longitudinal Crest corresponding to a Sulcus in the other: from this other you may separate it, by taking its superior extremity, and then drawing it downwards, while at the same time you assist its separation with the point of the scalpel; in this way you will obtain a long quadrangular process of white

matter, the outer surface of which will present grey flocculi of the torn tissue of the Spinal Marrow."

The cineritous matter is directly proportioned to the youth of the subject. It is placed in the interior of the Commissure, and consists of three portions, viz. a middle and two lateral. You will exhibit this arrangement by making a transverse section of the Spinal Marrow; if you then look on the cut surface, you will observe that each of the lateral portions has a crescentic form. Its posterior horn extends to the posterior collateral fissure; its anterior horn, thicker than the posterior, extends to the anterior collateral fissure. Its external surface is concave; and its internal surface, which is convex, is connected to that of the opposite side by the third or middle portion, which will appear on the cut surface like a line passing transversely and connecting the convexities of the lateral portions. The middle portion is thicker and broader in the neck, narrower and slenderer in the dorsal region; it becomes again larger, but does not continue to increase in the lumbar region. The

lateral portions are best marked in the upper part of the neck; they diminish as they approach the lower part of the dorsal region, where they manifestly enlarge again.

Two lateral canals have been described by Gall and Spurzheim in the Spinal Marrow. They made a transverse section through the Spinal Marrow of a subject eighteen days old, affected with Spina Bifida in the lumbar region, and they observed, after blowing on the cut surface, two openings, the size of a quill, separated from each other by the Commissure. In other subjects they succeeded in inflating these canals, particularly in newly born children: they observe that they are continued through the Medulla Oblongata and Crura Cerebri, into the Optic Thalami, where they form cavities, each the size of an almond when distended with air, and cease at the anterior extremities of the Optic Thalami, or commencement of the Corpus Striatum. Cloquet has repeated this experiment with success in two subjects. Marjolin, however, has found the interior of the canals thus

produced not smooth but floculent, and therefore infers that they have no existence in the natural state, but are produced by the rupture of the cincritious matter. Since writing the above, the English work of Spurzheim, 1826, has fallen into my hands, and I find he has changed his mind on the subject, and now considers these canals as the effects of blowing. Cloquet's opinion, however, shews that the subject deserves farther enquiry.

Some anatomists (Charles Etienne, Columbus, Senac, and Portal) fancied there was a central Canal in the Spinal Marrow, commencing in the fourth Ventricle at the pore, in which, as I have already observed, the Calamus Scriptorius terminates. "This canal," says Chaussier, "has always appeared to us to be the consequence of a morbid infiltration, and the manner in which air and mercury has been injected to exhibit it; it may be always formed when the Spinal Marrow is soft, and the air forcibly injected." Spurzheim, however, speaks with great confidence as to its existence. After mentioning his change of

opinion as to the lateral canals, he says, "They are not, however, I must here observe, to be confounded with the true Canal of the Spinal Cord, the Canal that exists in the interior of the Commissure, or apparatus of Union." "In the human Fœtus it is commonly visible during the first four or five months from conception. After this date it is generally, though not invariably, obliterated. This explains how its existence has been at one time admitted, at another time denied, and how, in extraordinary cases, it has been found even in advanced age."

THE DURA MATER.

The Dura Mater is a compact, white, semi-transparent Membrane, lined by a serous layer, that gives it a glossy appearance on its internal surface. That this latter is a distinct Membrane, Bichat has established, first, by dissection; secondly, by the Arach-

noid being found separate in some situations, as at the Sella Tursica; thirdly, by the Dura Mater not having the glossy appearance on the outer surface of the Spinal Dura Mater, and the inner surface of the fibrous sheaths of the Nerves, both of which are free; fourthly, by inflammation producing a thickening on its inner or serous surface, but not on its outer; fifthly, by the exhalation that occurs on its internal surface; and sixthly, by incrustations occasionally raising the serous layer as they do the internal coats of the Arteries.

The Arteries of the Dura Mater are very numerous: the largest of them are *middle menyngeal.* These arise (one on each side) from the internal maxillary Artery, as it lies between the internal lateral ligament and ramus of the lower jaw. From this origin it ascends vertically towards the Cranium, behind the external pterygoid muscle, and lying on the anterior margin of the internal lateral ligament; it then pierces the aural branch of the fifth Nerve, and enters the spinous Foramen between the internal late-

ral ligament behind,and the circumflexus palati Muscle in front. Having entered the Cranium, it sends backwards a branch grooving the internal surface of the squamous plate, and supplying the lateral and posterior part of the Dura Mater: the continued trunk goes upwards and forwards (sometimes in a groove, at other times in a bony canal,) towards the anterior inferior angle of the parietal bone. It communicates with the lacrymal Artery by a branch passing through the spheno frontal fissure. Another branch enters the Hiatus Fallopii, and communicates with the stylo-mastoid Artery, and a third accompanies the internal muscle of the Malleus into the Tympanum, to supply its mucous Membrane. It terminates in anastamosing with the Ethmoidal and Menyngeal of the opposite side. Besides this principal trunk, the Dura Mater is supplied by the ethmoidal Arteries in front, and posteriorly by the stylo-maistoid branch of the occipital, by a branch of the Pharyngeal that enters the foramen lacerum posterius, and by the Vertebral.

The Veins of the Dura Mater open into the different sinuses, to be described hereafter.

Nerves have never yet been satisfactorily traced into this membrane. Vasalva supposed it was supplied by the seventh pair; Vicussens and Duverny by the fifth; Winslowe by the fifth and eighth; and Lieutaud by the fifth, seventh, eighth, and tenth; while Haller, who investigated the subject with great care, has never been able to trace any Nerves in it; nor have Caldani, Asche, or Lobstein been more successful. It probably receives none but the branches of the sympathetic that accompany its Arteries.

Mascagni fancied he had discovered *Lymphatics* in the Dura Mater; and Cotunni and Meckel supposed they communicated with certain canals in the ear: they have never been demonstrated.

The functions of the Dura Mater may be considered in reference to the two laminæ that compose it; thus, in the Cranium, the external forms a periosteum for the bone, and sheaths for the Nerves; the inter-

nal forms a number of processes; and both contribute to form the sinuses.

1st, *The external Lamina* forms sheaths for the Nerves. These sheaths that leave the Cranium are continuous with the external Periosteum, but those that leave the spinal canal are lost in the cellular substance without. It also forms a Periosteum for the Cranium, but the Dura Mater differs from the Periosteum in other situations, in consisting of two laminæ, in its greater vascularity andin its slighter adhesion. This last observation principally applies to the adult subject; for in the young subject the Dura Mater is very adherent on account of the irregularity of the internal surface of the bone, and also, in the old subject, on account of the degeneration of many of the connecting vessels into fibrous bands, that hold it firmly united. The adhesion of the Dura Mater varies moreover in the different regions in which it is found. Thus in the Spinal Canal it is not at all connected with the surrounding bone,

but in the Cranium it will require a particular examination.

If you look on *the vault* of it, which you have removed, you will find the connexion feeble, except where it meets with sutures, thus it is easily detached from the parietal, the frontal, the upper part of the occipital, and the squamous portion of the temporal bones. Numerous fibrous prolongations cross the sutures, and are lost in the Pericranium: these are most numerous in the sagittal suture; the temporal and lambdoidal present fewer. There are but two foramina in the vault of the adult Cranium, and through these the Dura Mater transmits fibrous canals around the parietal veins, to be lost in the Pericranium.

If we examine *the relation of this membrane to the base* of the Cranium, we find it in front and *on the middle line* sinking into the foramen cœcum; here it adheres firmly, as also to the crista galli, which it embraces. In passing over the cribriform plate of the ethmoid bone, it sends fibrous canals round the

nervous filaments, to be lost in the fibrous layer of the pituatory Membrane, and in the periosteum of the orbit. It adheres firmly to the groove for the optic nerves, forms canals for the opthalmic arteries, and embraces the carotid arteries the moment they emerge from the cavernous sinuses, being afterwards lost on their coats: it lines the pituatory fossa, and here alone it is separated from the Arachnoid. Behind the fossa it presents a simple foramen for transmitting the sixth Nerve, and then descends on the Cuneiform process of the Occipital bone, as far as the Foramen Magnum, to the margin of which it adheres firmly.

If in *the lateral regions* you trace the Dura Mater, you find it has a feeble connexion with orbitar plates of the frontal bone, but is more intimately adherent to the lesser wings of Ingrassias, on the the free margins of which it forms *the sphenoidal folds.* After forming these folds it descends perpendicularly, closing the sphenoidal fissure: in this situation it sends off a broad prolongation, particularly thick on

the inside, and which passes into the orbit to be continuous with its periosteum: through this prolongation the third, fourth, and opthalmic nerves pass into that cavity.

In the greatest part of the internal temporal Fossa the Dura Mater has a slight adhesion. At the side of the Sella Tursica it is separated into two Laminæ to form the cavernous sinus; the outer wall of this cavity contains the third, fourth, and Opthalmic Nerves, as will be more particularly described in examining the orbit. Farther back the fifth Nerve is placed between two Laminæ of the Dura Mater. Of these the superior is attached to the posterior clinoid process, and the inferior, which is exceedingly delicate, is at first interposed between the fifth Nerve and cavernous sinus, and is afterwards lost on the inside of its Opthalmic branch. In this region, also, it sends fibrous canals round the superior and inferior Maxillary Nerves and middle Artery of the Dura Mater, and covers the Vidian Nerve on the upper surface of the petrous bone. You will next

find the Dura Mater descending on the posterior surface of the petrous bone : here it enters the internal auditory foramen to line the aqueduct of Fallopius. Opposite the Foramen Magnum a delicate layer of it surrounds the jugular vein, and it forms an envelope for each of the three divisions of the eighth Nerve.

2dly, *The internal Lamina* of the Dura Mater forms a number of processes, which separate and support the different portions of the brain. The most remarkable of these is the falciform process, which has already been described at page 7. The next to be examined is *the Tentorium* or septum, that separates the posterior Lobes of the Brain from the Hemispheres of the Cerebellum. This process presents a *convex margin* posteriorly, attached to the occipital, parietal, and petrous bones, and containing between its Laminæ, 1st, the Torcular Hierophili on the middle line ; more externally, the lateral sinuses ; and farther on, the superior Petrosal sinuses. The *concave margin* is shorter, presents a

groove for the fourth Nerve, and forms the posterior and lateral boundaries of an oval foramen, that is completed in front by the body of the sphenoid bone. If you contrast this foramen of the tentorium with the great foramen of the occipital bone, you will find that they are not parallel, in the natural position of the head, the occipital foramen being higher in front than behind, while that of the tentorium is higher behind than in front. Its centre is on a plane posterior to that in the Tentorium, which prevents the Brain from injuring the Spinal Marrow by its weight, and its small extremity is turned backwards, while that of the Tentorium is turned forwards. The parts transmitted through this foramen are the vermiform process, the annular protuberance, and the crura cerebelli. *The inferior surface* rests on the Cerebellum and lesser Falx; *the superior surface* supports the greater Falx on the middle line, and each of its lateral portions (which are convex from before backwards, but concave from within outwards,) support the posterior lobes of the

Cerebrum. The tentorium has a peculiar *termination in front.* Its concave edge is continued forward to the anterior Clinoid Processes, increasing on each side the depth of the Sella Tursica. The convex edge passes inwards under the preceding, and terminates in the posterior clinoid process; from this arrangement it results, that the edges cross each other in the form of the letter X, and that the surface of the Tentorium that looks downwards in the posterior part, comes to look inwards in this situation. *The lesser Falx* is the last process to be described. It is received between the Hemispheres of the Cerebellum, and contains the occipital sinuses. It is a triangular Lamina, the base of which is applied to the middle line of the inferior surface of the Tentorium. Its apex is divided into two portions, one of which passes at each side of the Foramen Magnum. Its posterior margin is attached to the internal occipital crest, and the anterior is free.

3dly, *The two Laminæ together* contribute to form the sinuses. Of these the first, or superior longi-

tudinal sinus has been described at page 4. *The inferior longitudinal sinus* is, as Bichat has observed, rather a vein enclosed in the Laminæ of the greater falx than a true sinus. It commences very small near the anterior third of the falx, where it is formed by the veins of this process itself; it then passes backwards and divides into two veins; *the inferior* follows the concave margin of the falx Cerebri, and descends nearly at a right angle with the Venæ Magnæ Galeni, to open into the anterior extremity of the straight sinus. *The superior* winds downwards and backwards, and opens into the straight sinus at about the middle of its course. This last branch alone has a small valve guarding its mouth. This sinus receives the veins of the falx, but very seldom any large vein from the brain; occasionally, however, there open into it two rather large veins coming (one on each side) from the Hemispheres. We may cut away the greater falx by incisions along its base, and lay open *the straight sinus*. This sinus takes a direction downwards and

backwards; it receives in front the Venæ Magnæ Galeni; behind it terminates in the Torcular Hierophili; it is triangular in the greatest part of its extent, but opens posteriorly by a rounded foramen. We occasionally meet in it some cerebral protuberances, principally about the mouths of the Venæ Magnæ Galeni; it is marked in all directions by fibrous fasciculi, that project upon its walls, but leave the centre unoccupied: these are numerous in front, but are fewer posteriorly. The whole of the cavity, and even of the fasciculi, presents the same polished appearance as the interior of the venous system in other parts. By its anterior extremity it receives the Venæ Magnæ Galeni and inferior longitudinal sinus; inferiorly it receives the superior veins of the Cerebellum, in about the middle of its course; posteriorly it opens into the *Torcular Hierophili.* This last cavity is of an irregular form, and placed in front of the internal occipital protuberance; the blood which it receives from the superior longitudinal and straight sinuses is transmitted by the occi-

pital and lateral sinuses to the jugular vein. Here then we find six openings into it; one superior and triangular from the superior longitudinal sinus, one anteriorly round from the straight sinus, two laterally oval from the lateral sinuses, and two inferiorly varying in size and appearance correspond to the occipital sinuses.

Each of *the lateral sinuses* commences at the Torcular Hierophili, from which it passes outwards, forwards, and a little downwards, grooving the occipital bone and the posterior inferior angle of the parietal, till it reaches the superior edge of the petrous bone; here it receives the superior petrosal sinus, and descends grooving the mastoid portion of the temporal bone and the base of its petrous portion, after this it again grooves the occipital bone, forming a curvature, the convexity of which looks inwards; it ultimately terminates in the foramen lacerum posterius, between the occipital and temporal bones. In comparing these two sinuses we almost always find the right larger than the left. From the Torcular

Hierophili to the superior edge of the petrous bone their section is triangular; from this to their termination their section is elliptical. Their interior presents none of the fibrous fasiculi that we observe in the others. Besides the petrosal and occipital sinuses, it receives above the lateral and inferior veins of the brain, and below the inferior veins of the cerebellum, as also veins from the tentorium and cavity of the tympanum.

The Occipital sinuses commence at the inferior part of the Torcular Hierophili by two distinct openings: from this they descend parallel at first; they afterwards separate and pass one at each side of the occipital foramen, where they become extremely small, and terminate by opening into the lateral sinuses. They receive in their course the veins of the lesser falx and inferior occipital fossæ.

The Petrosal sinuses arise close together from the posterior part of the Cavernous Sinus. The *superior* passes backwards and upwards lodged in a groove in the superior edge of the petrous bone, from which

it is separated in a part of its course by the nerve of the fifth pair: it is longer but narrower than the inferior; its section is triangular, and it is not marked on its inner surface by fibrous filaments. The *inferior* passes backwards and outwards between the petrous bone and the cuneiform process of the occipital, and terminates in the lateral sinus; it is wider at its extremities than in its centre; its inferior wall seems to be formed merely by the lining Membrane of the veins, though Bichat inclines to the opinion that it is supported by an extremely delicate Lamina of the Dura Mater, The petrosal sinuses transmit the blood from the cavernous into the lateral sinus; they receive veins from the Dura Mater, and a few from without that pass through the bones; they communicate at their junction in front with those of the opposite side by the transverse sinus or anterior occipital.

The Transverse sinus crosses the upper part of the Cuneiform Process of the Occipital bone, which presents a groove to receive it; it is variable in size, but

always considerable; it has obviously a cavernous structure, and receives many veins from the labyrynth of the nose; we often find one or two transverse sinuses behind this. As the longitudinal sinuses have been already spoken of, there only remain the cavernous sinus, the circular, and the transverse of the Sella Tursica.

The Cavernous sinus will be particularly examined in dissecting the orbit; at present I shall only observe, that it is placed at the side of the Sella Tursica; that it is formed by an internal Lamina, thin and applied to the side of the Sella Tursica, by an external directed downwards and outwards, and in front by the Lamina, closing the Sphenoid Fissure; that its walls are connected by fibrous filaments that give it a cavernous appearance; that it lodges the carotid Artery, sixth pair of Nerves, and branches of the Sympathetic; that the third, fourth, and first branch of the fifth pair of Nerves pass through canals in its outer wall; and lastly, that it communicates with

that of the opposite side by the circular and transverse sinus of the Sella Tursica.

The Coronary sinus surrounds the Sella Tursica; its anterior portion is placed behind the transverse groove for the optic Nerves; its posterior portion in front of, and above the Clivus or square plate of the sphenoid bone; these transverse portions are connected by two longitudinal portions, placed one at each side of the Sella Tursica. The Coronary communicates with the cavernous sinus, at the junction of the longitudinal with the posterior transverse portions, and receives the veins of the Dura Mater and Pituitary Gland.

The transverse sinus of the Sella Tursica is the last we have to notice; it connects the cavernous sinuses together, crossing the Sella Tursica, and placed beneath the Pituitary Gland.

The lateral sinuses may be considered as the trunks into which the other sinuses pour their blood. Thus *in front* they receive the blood of the petrosal sinuses; and *posteriorly* they receive the Torcular Hierophili

at their commencement, and the occipital sinuses (carrying blood from the Torcular Hierophili) at their inferior extremities. Let us now consider each of these sources separately.

1st, The Cavernous Sinus, placed at the side of the Sella Tursica, receives the blood of the Opthalmic Vein in front, and of the coronary and transverse sinus of the Sella Tursica internally; this blood it conveys to the Petrosal Sinuses, which, after communicating with those of the opposite side, transmit their contents to the lateral sinuses.

2dly, The superior longitudinal Sinus commences at the foramen in front of the Crista Galli, and communicates with the veins of the forehead by small vessels that enter along the Sagittal Suture. Others repair to it from the Diploe of the Cranium, and one joins it after passing through the Parietal Foramen: besides these it receives many from the Dura Mater, and all those that lay on the convexities of the Hemispheres. The blood from all these sources is conveyed to the Torcular Hierophili, where it meets

another current that arrived by the straight sinus, and was formed by the contributions of the inferior longitudinal Sinus and Venæ Magnæ Galeni.

3dly, The Occipital Sinuses convey a portion of the blood of the Torcular Hierophili to the inferior extremities of the lateral sinuses.

In addition to these three sources the lateral sinuses receive the blood of the lateral and inferior veins of the Brain, and the inferior veins of the Cerebellum, and ultimately discharge their contents into the internal jugular vein.

The sinuses are connected with the general venous system only by their lining Membrane. The uses ascribed to them are to moderate and equalize the flow of blood arising from regurgitation, and according to others, for retarding its progress for the purpose of Cerebral secretion.

When the Dura Mater of a living animal is exposed, an alternate elevation and depression is observed. This was attributed by Pacchioni, Willis, and Baglivi, to muscular fibres, which they fancied

they had discovered in the Membrane, and by Bauhin and Fallopius to the pulsation of the Meningeal Arteries. The first opinion is refuted by the firm adhesion the Membrane has to the Cranium, and the second, by the Cerebral Mass continuing to rise and fall even after the Dura Mater is removed. Galen attempted to explain this last circumstance by the action of the air, which he supposed to be conveyed by the lungs and spinal canal into the skull, and to raise the Cerebral Mass during *inspiration*. Schlitting made experiments to prove that, contrary to the opinion of Galen, the elevation of the Brain occurred during *expiration* and not during inspiration; this opinion was assented to by Lamure and Haller, who afterwards investigated this subject conjointly. Lamure supposed a cavity to exist between the Dura Mater and Pia Mater; that during expiration the collapse of the lungs obstructed the blood in the Pulmonary Artery and right side of the Heart: in consequence of this the column descending through the superior Cavæ regurgitates into the sinuses and

elevates the Brain. Haller conceives that regurgitation may occur in forcible, but only stagnation can occur in ordinary acts of exspiration. His own observations, and the testimonies of other authors, led him to conclude that the Cerebral Mass was affected by *two* orders of motions, one depending on respiration, and the other on the pulsation of the Arteries of the Brain, an opinion which was also maintained by Vic D'Azir. Richerand, who has investigated this subject, is led by his experiments to the following conclusions; 1st, that there is no cavity either between the walls of the ventricles, as Lorry supposed, or between the Membranes of the Brain, and that these motions cannot occur so long as the skull remains entire: 2dly, that the process*

* The order of motions depending on respiration, though denied by Richerand, is admitted by many other physiologists.—See on this subject Elliotson's Blumenbach, p. 107; Milligan's Magendie, p. 107; and Bostock's Physiology, vol. ii. p. 53.

of respiration has nothing to do with this phænomenon; for even admitting a stagnation and regurgitation of blood into the jugular vein, this effect could not follow, the veins being placed above the brain, some of the sinuses in the centre, and those at the base not admitting of sufficient distension: and 3dly, that the elevation of the Brain is synchronous with, and solely produced by the pulsations of the Arteries at its base.

The Dura Mater of the Spinal Region is continuous with that of the Cranium, but differs from it in many respects: its external surface does not form a periosteum for the bone, the internal surface does not send processes into the Spinal Marrow, and it is altogether unconnected with the formation of the sinuses; yet these are the functions usually assigned the Cranial Dura Mater.

When you examine the canal that contained the Spinal Marrow and its Membranes, you observe on the backs of the bodies of the Vertebræ a ligamentous band extending from the axis to the Os Sacrum.

This is the posterior Vertebral ligament; it appears to be continuous superiorly with the occipito-axoidean ligament, Along the margins of this you observe two venous canals ascending, termed the Vertebral Sinuses, which do not communicate with the sinuses in the Cranium, nor are they formed like the latter in the Dura Mater. More externally you see the pedicles which bound the openings by which the nerves go out, and still more externally the bases of the transverse processes; the posterior boundary which you have removed consists of the Laminæ of the Vertebræ united together by the ligamenta subflava and the bases of the spinous processes.

The Vertebral Sinuses commence opposite the anterior condyloid foramina; each of which transmits a vein, by which the sinuses communicate with the internal jugular vein. The proper membrane of the sinus adheres to the circumference of this foramen, and its lining membrane passes through and is continuous with that of the vein: they approach each other as they descend, and are lodged in the de-

pressions between the bodies of the vertebræ and the transverse and articular processes. Their proper membrane seems to be continuous with the posterior vertebral ligament. Their calibre is inversely as the breadth of this ligament; thus in the cervical region where it is broad, the sinuses are narrower, and their capacity increases in the dorsal and lumbar regions, where the ligament grows narrower. In the latter situation they are alternately constricted opposite the fibro-cartilage, and dilated opposite the bodies of the Vertebræ. The dilated portions are received into corresponding excavations in the margins of the vertebral ligament: their continuity may be shown by passing a probe from one dilatation to another above or below it, and cutting on the probe. In the interior we observe membranous bands, similar to those in the cerebral sinuses, which Bichat concluded to be formed of the lining membrane of the veins. Each of these sinuses communicates *internally* with that of the opposite side by others that are transverse, and pass before the posterior verte-

bral ligament, lodged in grooves in the bodies of the vertebræ, and the calibre of each is proportional to the depth of this groove, which is sometimes extremely deep, particularly in the lumbar region: they may be laid open by cutting the ligament transversely, and you will see that they receive many considerable veins from the spongy tissue of the Vertebræ, which is, indeed, the principal source of the blood of the vertebral sinuses. *Externally* the longitudinal sinuses communicate with the posterior branches of the vertebral, lumbar, and intercostal veins. *Posteriorly* they receive very numerous, but small, branches from the Dura Mater to these I have already directed your attention. Inferiorly the sinuses change their appearance as they enter the sacral canal, they are no longer sinuses but simply cylindrical veins placed at the sides of the false vertebræ of the sacrum, and involved in a large quantity of adipose substance. *In this region* they communicate externally in an obvious manner, opposite the third anterior sacral foramina, with the lateral

sacral veins; internally they communicate with each each other by transverse branches, the lowest of which is the largest, and even equals the veins it connects, so as to present a kind of anastamotic arch that terminates the sinuses. The blood received from the Dura Mater and bodies of the Vertebræ are transmitted through these sinuses into the spinal, intercostal, lumbar, and sacral veins.

The veins of the Spinal Marrow accompany the Arteries, and open into the inferior veins of the Cerebellum.

THE ARACHNOID MEMBRANE.

The Arachnoid is a serous Membrane, and lying between the Dura and Pia Mater. It received its present name from a learned society in Holland, in the year 1665. By some anatomists it has been confounded with the Dura Mater, to the internal sur-

face of which it corresponds, and by others (as Lieutaud and Caldani) it has been considered as an external layer of the Pia Mater. With the former of these it has been contrasted at page 146, and with the latter at page 30.

Bichat, by whom it was first accurately described, has advanced many reasons for referring it to the class of serous Membranes. He argues from a consideration of its texture, vital properties, functions, morbid affections, and anatomical arrangement.

1st, As to *texture*, it is pale, semi-transparent, and reducible, by maceration, to the cellular Membrane. 2dly, As to *properties*, its occasional distension by fluids, and subsequent return to its original capacity, proves its extensibility and contractility; and its functions imply an organic contractility and an organic sensibility, liable to be exalted into animal sensibility by inflammation. 3dly, Its *functions* are to connect mechanically the organ it covers, while it insulates its vital properties: it exhales, moreover, an albuminous fluid for facilitating its motions and prevent-

ing adhesion; and has the property of absorbing, as Bichat proved, by comparing the results when coloured fluids were injected into the Crania of living and dead dogs. 4th, Its *morbid affections* also are those of serous Membranes, as dropsy, effusion of lymph, &c. And lastly, we will now find, on tracing the Membrane, that it is a shut sac, and agrees in its *anatomical characters* with other Membranes of that class.

We may form a general idea of the anatomical arrangement of the Arachnoid Membrane, by considering it as a bag, consisting of two concentric Laminæ, *not adhering together*. The internal Lamina embraces the Brain, Cerebellum, and Spinal Marrow, with the interposition of the Pia Mater. The external Lamina lines the Dura Mater of the Cranium and Spinal Canal. These two Laminæ are traversed by Arteries that enter the Cerebral Mass, and by Nerves, Veins, and the Pituatary Process, that go out. The openings for these parts have not, however, defined margins for the edges of any open-

ing in the internal Lamina, is continued over the transmitted part, to be continuous with the edge of the corresponding opening in the outer Lamina, and *vice versâ.* In this manner sheaths are formed for the parts transmitted, and the continuity of the two Laminæ is preserved, so that the whole Membrane forms a shut sac; the cavity of which is the space between the two Laminæ

We may now commence tracing it; 1st, superiorly, where one portion of it covers the convexity of the right hemisphere, without entering the Sulci, and the other, in a similar manner, covers the left hemisphere: these two portions are continuous, by descending into the great longitudinal fissure and meeting under the falx. In front we trace it over the anterior lobes, then on their inferior surface, where it passes from one anterior lobe to the other, without entering the fissure that separates them. In this region it covers the inferior surface of the olfactory nerves. The nerves themselves are transmitted through openings in the Arachnoid, the edges

of which openings are continued forward, forming sheaths for the extremities of these nerves, and are ultimately continuous with the Arachnoid lining the Dura Mater. Similar sheaths or canals surround the optic Nerves, and are not reflected on their fibrous canals continued from the Dura Mater, till in the orbit. Another sheath surrounds the Pituatory Process, covers the upper surface of the Pituatory Gland, and passes over the Dura Mater on the side of the Sella Tursica: in like manner the Carotid Artery has a sheath. We may continue to trace the Arachnoid, *on either side,* over the inferior surfaces of the hemispheres, (without sinking into the fissure of Sylvius,) then over their posterior extremities, and on their upper surfaces: but *on the middle line* it covers the floor of the third Ventricle, being in this situation free on both sides; then passes over the Pons, in the neighbourhood of which it gives sheaths to thethird, fourth, fifth, sixth, and seventh Nerves. Behind the Pons it descends on the front of the Spinal Marrow to its lower extremity, ascends on its pos-

teiior part, and these descending and ascending portions are continuous laterally, so as to form a membranous tube, containing the Spinal Marrow. This tube sends sheaths round the nerves and vessels that go out. From the back of the Spinal Marrow the Arachnoid proceeds to the inferior surface of the Cerebellum, after closing the fourth Ventricle, and giving sheaths to the eighth and ninth pair of Nerves and the Vertebral Artery. We trace it next on the superior surface of the Cerebellum, as far forward as the head of the Vermiform Process, from which it passes over the Corpus Callosum, after giving sheaths to the Venæ Magnæ Galeni.

Bichat was farther led to consider *the lining Membrane of the Ventricles* as a serous Membrane, and to suspect its continuity with the external Arachnoid: for if the Ventricles were lined by Pia Mater only, no fluid would remain in the lateral Ventricles, but would descend through the cells of the Choroid Plexus, and escape by their inferior Cornua. These considerations led him to a careful examination,

which fully confirmed his previous supposition. " I have said," says Bichat, " that after covering the " Corpus Callosum the Arachnoid descends to the " Cerebellum, but that by an oval opening, between " these two parts, a prolongation of it sinks into the " middle Ventricle.

" This opening first embraces on all sides the " Venæ Magnæ Galeni and their numerous branches, " each of which, through receiving a covering from " the Arachnoid, and transversing it in all direc- " tions, is yet exterior to its sac. It is afterwards " prolonged under these veins, between the Pineal " Gland and the Tubercula Quadrugemina, and ter- " minates in the middle Ventricle of the Brain, in " forming a distinct canal. This canal, as well as " the Venæ Magnæ Galeni, passes through the pro- " longation of the Pia Mater, which sinks under the " Corpus Callosum to form the Velum Interposi- " tum.

" In order to find this canal you must saw with " great caution through the Cranium, and raise

" gently the falx, otherwise the shakes given it may
" be communicated to the Tentorium, the Venæ
" Magnæ Galeni, and particularly that part of the
" Arachnoid that comes from the Corpus Callosum,
" and, by tearing it, destroy the opening, a circum-
" stance that usually happens when these rules are
" not attended to. The Brain being exposed, you
" gently raise the posterior extremities of the Hemis-
" pheres, at the same time separating them. The
" Venæ Magnæ Galeni are then seen, going out of
" the canal which contains them, and the oval orifice
" of which is very apparent. Sometimes, however,
" the edges of this orifice embrace the veins so closely,
" that we can only distinguish it by a small fissure
" at one or other side, where you might, at first
" glance, suppose there was a continuity. Slide,
" then, a probe along these vessels from behind for-
" wards, and when it has entered a little way roll it
" gently, so as to remove the adhesion, and the open-
" ing will then be rendered very evident. To satisfy
" yourself that this leads into the middle Ventricle,

" push a probe gently under the Venæ Magnæ " Galeni, and it will readily penetrate the Ventricle. " After the Fornix and Corpus Callosum are raised, " but the Velum Interpositum remaining in situ, cut " through the latter on the point of the probe, and you " will find the Membrane smooth and polished, and " not at all torn, for the admission of the probe. We " occasionally find a resistance, so that, perhaps, we " cannot pass the instrument; this is owing to the " veins which empty themselves into the Venæ " Magnæ Galeni crossing and interlacing, so as to " form a kind of areolar appearance, and impede the " instrument. In this case, if you wish to demon-" strate the communication, you should withdraw it, " and throw in mercury, inclining the head so as to " allow it to gravitate into the third ventricle. Air " may also be made to pass into the middle, and " thence into the lateral Ventricles by the openings " situated behind the origin of the Fornix. If we " raise the latter, so as to expose the Velum Interpo-

" situm, we will observe it raised every time air is
" thrown in.

" As to the internal orifice of this canal of com-
" munication, we will find it in the inferior part
" of the Velum Interpositum. To see it, we should
" throw back the Velum, either along with the Fornix
" or after this latter has been removed. The Pineal
" Gland remains attached to the Velum, and then
" above and in front of this gland, we see a range of
" Cerebral granulations, having the form of a tri-
" angle, with the apex turned forwards. It is at the
" base of this triangle that we find the internal orifice
" of the canal of the Arachnoid Membrane. A
" probe introduced here will pass outwards (back-
" wards) over the superior part of the gland which
" the canal surmounts. Sometimes we meet the
" same difficulty in passing a probe here as from
" the outer orifice, in consequence of the Venæ
" Galeni; but, with a little address, we may always
" succeed without tearing the Membrane.

" It appears, then, from what has been said, 1st, that

" the Membrane of the Ventricles is analogous in its " appearance and nature to the Arachnoid—is a pro- " longation of it—and that the medium of communi- " cation between them is the canal, of which I have " spoken. 2dly, That this prolongation, still thinner " than the Arachnoid, of which the tenuity is very " great, first lines the middle Ventricle, and then de- " scends into the fourth by the aqueduct; that here it " closes the different openings by which the Pia " Mater enters carrying in vessels; that it passes " through the two openings of communication of " the lateral Ventricles, which openings are best seen " in dissecting from the base upwards; that it lines " these Ventricles and their eminences; that it is " reflected on the Plexus Chorides; and closes, (all " along the concavity of the Corpora Fimbriata,) the " communication (between the cavities and the ex- " terior,) by which the Pia Mater enters, to be con- " tinuous with the Plexus Choroides, which is prin- " cipally formed by the Velum Interpositum. From " this account there will appear a striking ana-

" logy between the Arachnoid lining the Ventri-
" cles, and the Peritoneum forming the cavities of
" the Epiploa; and between the orifice above de-
" scribed, and the Foramen of Winslowe. Such,
" however, is the extreme tenuity of the internal
" Arachnoid, particularly where it covers the Cere-
" bral surface, that it is impossible to raise it. Its
" existence in the canal, as far as the internal orifice
" under the Velum Interpositum, is very evident,
" as also opposite the fissures of communication;
" but, in the Ventricles, I admit that its presence is
" rather to be inferred from its exhalation, than
" proved by actual dissection."

PIA MATER.

The third, or most internal Membrane of the Brain, is the Pia Mater: it has been already examined at page 29.

THE

PHYSIOLOGY

OF

THE NERVOUS SYSTEM.

THE Nervous mass is found to consist of two substances, differing in their sensible qualities: one of which is termed the grey or Cineritous substance; the other, the Medullary or white.

The grey substance is distributed either on the surface, where it is termed the *cortical* matter, or is mixed with white substance in the interior, so as to form masses that Spurzheim terms *ganglions.* Vic D'Azir supposed it to be fibrous in its structure, but his opinion is not generally admitted. Praxagoras

considered it as a continuation of the Arteries, but Albinus and Sœmmering have shown, that there is a part of it which the injection will not enter, and therefore, that it contains something more than vessels: Ruysch, Lewenhoeck, and Haller likewise maintained its vascular structure. Malphighi supposed it to be a congeries of glandular Follicles,

The white substance was originally supposed to be of the nature of marrow. Descartes supposed it to be tubular, and that it served to convey the vital spirits to the Nerves. Fontana supposed the Medulla to be "composed of irregular cylinders or transparent canals, which fold as the intestines do," Its fibrous nature has been maintained by the Cartesians, Malphigi, Lewenhoeck, Vieussens, Steno, and most modern anatomists.

De La Torre supposed *the entire of the Nervous mass* (the Medulla of the Nerves included) to be formed of a number of globules swimming in a transparent fluid. Prochaska supposes that both the cincritious and medullary matter are formed of globules,

united by a transparent cellular Membrane. The globular structure of the Brain has also been maintained by Majendie, the Wenzels, Bauer, and Home; the latter supposes them to be connected together by a gelatinous substance, serving for the communication of sensation and volition, and tending to confirm Hunter's Doctrine of the Materia Vitæ. Doctor Edwards supposes the globules to be all of the same size, in which respect he differs from Bauer. He has observed a fatty matter between them, probably the same as the gelatinous fluid of Bauer and Home. Dutrochet, who has made subsequent observations, agrees with Edwards as to the existence of globules, but he conceives that they are not elementary bodies, but contain within them other globular corpuscles filled with nervous matter.

The points that seem to be most generally agreed on amongst authors are these, that the white substance, carefully examined, presents a fibrous structure—that the grey substance is considerably more vascular, but not a congeries of vessels exclusively,—

and that when submitted to examination with powerful glasses, both of them present a globular structure.

As to *the uses of these substances,* the cortical part was formerly supposed to secrete the animal spirits, and the Medullary part to transmit them to the Nerves, resembling in their functions the cortical and tubular structure of the kidney. Gall and Spurzheim suppose the grey substance to be the matrix or source of the white fibres, by which, however, they do not mean that the white substance is formed or secreted by the grey, but only to announce "the fact of a gelatinous or greyish state of the brain preceding its fibrous and white condition," as "bone begins by being gelatinous, is then cartilaginous, and ultimately solid and earthy." It has been objected to this opinion, that the brain of the Fœtus is not grey, but of a pale colour. To this Spurzheim replies, that the two substances should be distinguished not by their *colour,* as this is not an essential quality, but by their structure, and that

instead of grey and white, we should employ the terms pulpy and fibrous, and the pulpy structure they maintain to be the predominant part of the fœtal brain. The fibrous portion they suppose to consist of two orders of fibres, a converging and diverging. The former arising in the cortical substance, and terminating on the middle line in commissures; the latter arising from the Medulla Oblongata, afterwards reinforced in the different ganglia, and terminating in the cortical substance.—*See page* 97.

Great credit is, no doubt, due to Gall and Spurzheim for the clear manner in which they have described the course of these two sets of fibres; yet I must observe, that before their time Vieussens, in his Neurographia, page 58, without applying the above name, described the fibres of the Brain arising from the cortical substance, and terminating *some* in the Corpus Callosum, and *others* in the Medulla Oblongata. Spurzheim does not appear disposed to admit an opinion lately advanced by Foville and

Grandchamp, that the cineritious matter presides over the intellectual functions, and the white or medullary mass over locomotion, as deduced from certain pathological observations. Resembling this is the opinion of Sir Everard Home, who supposes the grey substance to be the seat of memory, finding this function impaired when pressure is made on it, while the white substance may be compressed, as by the fluid of Hydrocephalus, without the powers of the intellect being at all diminished, but often on the contrary increased. Tiedeman conceives that the cortical substance has no other use than to convey the Arterial blood to the more perfect Nervous substance.

The Cerebral matter, when submitted to chemical analysis, was found by Vauquelin to have more than one-fourth of its solid contents formed of a fatty substance; nearly a third was Albumen, imperfectly coagulable, and differing from that found in the blood; the remainder is composed of Osmazome,

Phosphorus, Acids, Salts, and Sulphur. The following table represents their proportions :—

Water, - - -	80.00
White fatty matter, - -	4.53
Red fatty matter, - -	0.70
Osmazome, - - -	1.12
Albumen, - - -	7.00
Phosphorus, - - -	1.50
Sulphur and Salts, as Phosphate of Potash, ——— of Lime, ——— of Magnesia, -	5.15

The ancients considered the Brain as the centre of the Nervous system, and the Spinal Marrow and Nerves as prolongations from its hemispheres. Winslowe, however, maintained the independence of the sympathetic Ganglions, and separated them from the rest of the Nervous mass; in this he was afterwards followed by Willis, Vieussens,

Richerard, Cuivier, Bichat, &c., the latter of whom has made the Ganglions the centre of organic life. The division of the Cerebro-Spinal mass itself into a number of apparatuses, each of which presides over a distinct faculty, is of old date. Laurentius observes, "Universa Arabum Scholæ mansiones multas in cerebro statuit et singulis facultatibus singulas sedes assignat." The same opinion may be found in the writings of Diemerbroeck, and subsequent authors. Gall and Spurzheim not only adopted this opinion as to the multiplicity of apparatuses, but assigned to each of them the form of a Ganglion, and a proper faculty. They maintain that the independence of the Spinal Marrow may be proved by its existing without the Brain, as in Acephalous monsters; by its not observing a uniform ratio to the Brain in the different orders of animals, and by its not diminishing in size as we trace it down the Spinal Canal. The Medulla Oblongata, in like manner, Spurzheim conceives to be independent both of the Brain and Spinal Marrow; he even sup-

poses the Spinal Marrow itself to consist of a series of separate Ganglia. Serres has, however, denied the justice of this opinion. Tiedeman also observes, that if this had been its structure, it is probable it would have been apparent in the fætal state; yet nothing of this kind can be detected.

Many of the facts that prove the independence of these different parts may also serve to shew the order of their importance. Thus, as we descend in the scale of animal existence, we find the Brain and Cerebellum disappear before the Spinal Marrow, and this last before the sympathetic system: and again, we find there are many cases on record of Acephalous Fœtuses, and one only in which the Brain existed without the Spinal Marrow.

The functions of this system have been classed into the Nervous and Sensorial. *The Nervous functions* are—*sensation,* by which it receives impressions; and *irritation,* by which it stimulates the muscles to contract. To these a third has lately been added by Dr. Philip, namely, the property of

separating the different secretions (among which he includes animal caloric) from the blood. These functions consequently serve for the communication of the Cerebro Spinal Mass with extraneous bodies, or with other parts of the frame.

The Sensorial functions are, perception and volition. By perception, the impressions made on the seat of the sensations are conveyed to the sensorium, or seat of the thinking principle; and by volition, the thinking principle, acting through the Sensorium, influences that part of the mass in which irritation resides, so as to produce muscular contraction. The Nervous were formerly confounded with the Sensorial Functions: Le Gallois, and particularly Dr. Philip, are the persons to whom we are indebted for drawing a clear line of distinction between them. It has been ascertained, that on removal of certain parts of the Nervous Mass volition ceases, so that the animal loses all power *of the will* over the muscles; but still the Nervous function termed irritation, or the power of exciting the muscles remains, as

may be proved by stimulating the Brain or Spinal Marrow, when contraction of the Muscles will follow. In like manner Dr. Philip distinguishes between Sensation and Perception. Sensation occurs when impressions are conveyed by the Nerves to the Cerebro Spinal Mass; but in order that perception should follow, it is necessary that the sensation should be farther transmitted to the Sensorium, or seat of the thinking principle. We have no evidence of a perception being produced in the mind of another person unless it be followed by some volition or act of the will. When perceptions are produced in our own mind we are usually *conscious* of them. Dr. Philip does not suppose, however, that consciousness is necessary to perception. A person labouring under Apoplexy will perceive the uneasy sensations transmitted from the collapsed lung, and will *voluntarily* employ the muscles of respiration to relieve them, without being at all conscious of such perceptions having occurred.

The loss of the Sensorial Functions produces the

state we term death; but the Nervous Functions may continue for a short time after life has ceased. Thus a stimulant applied to the brain of a person recently dead will cause contractions of the muscles, and Dr. Philip states, that sensation may remain also. I do not find, however, that he has offered any experiment in proof of this; the reason of which is probably this—to produce death we must destroy perception and volition, and when we destroy volition we do not indeed destroy sensation, but we destroy the evidence of sensation or perception having occurred. This should also be borne in mind in making experiments to ascertain the seat of the sensations. Thus Flourens is said to have removed the Hemispheres of the Brain, and found the animal no longer gave any evidence of sensibility to sounds, &c. Now it is obvious that we should not infer from this that the seat of sensation has been removed; for removing the seat of volition would deprive the animal of the power of evincing his sensibility. If the arguments to be offered hereafter to

prove *secretion* a Nervous function, be deemed conclusive, it will be found to agree with the other Nervous functions in continuing for a short time after death. I shall now proceed to make a few remarks on each of these functions.

On the subject of *sensation* I have necessarily anticipated above much of what was to be said. I have defined sensation, and distinguished it from perception, and pointed out the difficulty of ascertaining its seat. Among the impressions conveyed are those of the organs of taste, smell, hearing, sight, and touch. The sensible Nerve of a muscle conveys information as to the state of its contraction, as well as concerning external impressions, and the former kind of sense is, as Mr. Bell has observed, very delicate, though the latter is not. Besides these a variety of other sensations may be transmitted, as of heat, cold, hunger, thirst, and the sexual feelings.

The next property of the Nervous system is *irri-*

tation, by which it stimulates the Muscles to contraction. In the consideration of this part of the subject I shall first state the prevailing opinion before the time of Haller, then Haller's opinion, and conclude by inquiring how the question is affected by the experiments of Le Gallois, Philips and Brodie.

Before the time of Haller it was supposed that Nerves were the only direct stimulants of the Muscular fibre, and that in all cases in which a mechanical or chemical stimulus, applied to a Muscle, produced its contraction, the primary action was on the Nerves, and that through their intervention it caused the contraction of the Muscle, which if voluntary received its Nerves from the Brain or seat of Volition, but if involuntary, from the Cerebellum. Haller opposed this opinion: he maintained that irritability was a property inherent in the Muscular fibre itself, and could be brought into action without the intervention of the Nervous power, and he explained the difference between the two sets of Muscles, by supposing the Nervous power was the

proper stimulus of the voluntary muscles; but that the involuntary were stimulated by different substances, as the heart by its blood, the intestines by their contents, &c. and was slow in admitting that the Nervous system, even under the influence of the passions, could affect them.

The followers of Haller's doctrine argued in favour of this opinion; 1st, that the contractility of a muscle was not proportioned to its quantity of Nerves. Thus the heart has few Nerves; Sœmmering, and his pupil Behrends, supposed it had none, the Cardiac Nerves being intended for the vessels, and not for the muscular fibres of the heart. The answer given to this argumeut is, that Scarpa has shown that the heart is supplied with Nerves as any other muscle, and that, though few, they are sufficient. A second argument of the Hallerians is, that the heart will contract where there is no Brain or Spinal Marrow, or after being removed from the body. To this it is replied, that the Nerves themselves are capable of generating Nervous power, and are the

cause, in such case, of its contraction. A third argument adduced, is the existence of irritability in plants, and in the lower order of animals, in which no Nervous system can be detected. Our ignorance, however, of the nature of irritability in plants, and of the structure of the lower order of animals, has been considered as a sufficient reply to this. It has been urged moreover, that the formation of the heart precedes that of the Brain, and also, that the coagulum of the blood has been made to contract by galvanism; both of these have been denied, the former by Sir E. Home.

The opponents of this doctrine were not content with replying to their adversaries' arguments, but urged a number of distinct facts in support of the opposite opinion, such as, that there were no contractile parts without a supply of Nerves—that one fibre contracting when another is stimulated proves a Nervous communication—that stimulants will produce their respective effects equally well upon the Nerve going to a Muscle as on the Muscle itself—and lastly, the

influence of the passions over some of the involuntary Muscles, as the Heart, has been considered as one of the strongest objections to this doctrine.

Prochaska attempted to remove the last objection by adopting the opinion of Johnstone, that the Ganglions served to intercept the Nervous influence; and he supposed that their resistance was occasionally overcome by the violence of the passions.

In this manner the controversy was carried on between the Hallerians and their opponents, when the experiments of Le Gallois appeared for a time to have entirely overthrown the doctrine of Haller. Le Gallois had observed that sensation and muscular contraction might be preserved in decapitated animals, provided the Spinal Marrow was entire, and artificial respiration kept up; or if the Medulla Oblongata was allowed to remain, respiration was carried on naturally, If, however, respiration was not maintained, or the Spinal Marrow was crushed, both sensation and muscular contraction were lost. This led him to the following conclu-

sions; that the Nervous power was essential to the contractility of both the voluntary and involuntary muscles,—that the Spinal Marrow, and not the Brain as Haller supposed, was the centre from which Nervous power was propagated,—and that the motions of the chest, by which air was taken into the lungs, depended on the Medulla Oblongata. He also inferred from his experiments that each of the parts supplied *directly* from the Spinal Marrow depended for its life *on that part only* from which it received its nerves, and consequently that the opinion that injury of the Spinal Marrow at any part necessarily causes paralysis of all the body *below it* is unfounded. Dessault relates a case in which the Spinal Marrow was divided entirely through in a transverse direction, and yet paralysis of the lower extremities was not produced, and Le Gallois refers to similar cases.

The involuntary muscles, as the heart, differ according to Le Gallois, from the voluntary, in receiving their Nerves from the Spinal Marrow, *not di-*

rectly, but through the intervention of ganglions, which have the effect of making the parts supplied depend not upon any particular part of the Spinal Marrow, but upon the whole of it; consequently destruction of any part of the Spinal Marrow can only weaken the power of the heart and vessels, but not destroy the circulation entirely. A curious fact was ascertained in the course of his experiments, that if the Spinal Marrow be exposed, and the power of the circulation weakened by destroying a portion of it, it may be restored to its former vigour if the animal be decapitated, and respiration artificially maintained; for in this way the heart will be limited to a smaller sphere, and therefore will act with greater vigour. The same effect will follow if, instead of decapitating the animal, we tie some of the larger vessels. These conclusions of Le Gallois were very generally admitted till disproved by subsequent enquiry.

Mr. Brodie made experiments to refute two principal positions of Le Gallois. The first is, that the

voluntary muscles depend for their contractility on the portion of the Spinal Marrow from which they derive their Nerves. To disprove this he made the two following experiments. In the first, he divided all the parts connecting the fore-leg to the trunk, of a dog, except the Axillary artery and vein. The divided edges of the skin were then united by sutures. In twenty-four hours afterwards, an incision being made in the forearm, the Arteries bled freely, and the blood was of a bright scarlet colour. The muscles were made to contract as freely by means of the voltaic battery as they previously did under the influence of the will. I may here refer to a similar case mentioned by Pariset, the editor of Le Gallois's works, (page 42, vol. i.), in which a tumour pressed on the Axillary Plexus, so as nearly to divide it, and yet the sensibility and motion of the upper extremity were unaffected. "Were they maintained," he inquires, "by the Nerves accompanying the Arteries?"

Mr. Brodie, in his second experiment, destroyed the posterior part of the Spinal Marrow of a frog,

and in five months afterwards the muscles of the hind leg were capable of powerful contractions under the influence of the galvanic battery, and, even in six months more, retained their contractility, though it appeared, on killing the frog, that no attempt was made to regenerate the injured portion of the Spinal Marrow.

The second position of Le Gallois denied by Mr. Brodie is, "that the blood is the proper stimulus of the heart." To disprove this he also made two experiments: in the first he divided the carotids of a full grown rabbit; sensibility and voluntary motion ceased in thirty seconds; at the end of two minutes he opened the thorax, and found the heart contracting with vigour and regularity, though the right ventricle, on making an incision, was found to contain little blood, and the left ventricle none. In another experiment a rabbit was rendered apparently dead by inoculation with the Woorara poison. The Thorax was then opened, and the Aorta and inferior Cava divided: a profuse discharge of blood ensued,

and yet at the end of two minutes the contractions of the heart were as regular, frequent, and vigorous as in the living animal. Mr. Brodie supposes the heart rather owes its contraction to certain impressions communicated through the Nervous system. His reasons may be thus briefly stated :—1st, the contraction of the heart becomes more frequent after loss of blood ; 2dly, when the blood flows into the auricles of the heart the valves cannot oppose its flowing into the ventricles, and then auricles and ventricles would be stimulated, and contract at the same time; 3dly, the passions influence the contractions of the heart; and 4thly, it is proved by analogy,—of the diaphragm which is paralysed by division of the Phrenic Nerves,—and of the uterus, which in cases of extra uterine conception, will begin contracting at the same period as in common pregnancy, and therefore cannot owe its contraction to the stimulus of its contents.

Dr. Philips agrees with Le Gallois, that the voluntary muscles are influenced by a particular

part,—and that the involuntary (on account of the intervention of the ganglions) are influenced by the whole—of the Spinal Marrow. He does not believe, however, that the Brain or Spinal Marrow are *essential* to the contractile powers of *either* set. He has found that the cause of these functions ceasing by the destruction of the Spinal Marrow, in the experiments of Le Gallois, was the sudden manner in which the operation was performed; but if gradually done, the entire of the Cerebro Spinal Mass may be removed or destroyed without injuring the life of the trunk. He also denies the correctness of Le Gallois's inference, that the respiratory motions depend on the Medulla Oblongata; for Le Gallois himself has proved, that the Spinal Marrow, from which the Nerves of the muscles employed in respiration arise, can excite the muscles independently of the Brain. Dr. Philips, however, admits that the integrity of the Par Vagum is essential to respiration; but he explains the matter differently from Le Gallois. He supposes that the Vagum serves for conveying to the

Brain sensations arising in the lungs,—that by their division the perception of these, and consequent volition, is cut off, and therefore respiration, which is *a purely voluntary act,* must cease, and death be produced by a series of changes that will be detailed hereafter. It may be objected to respiration being voluntary, that it cannot be long suspended at will. To this Dr. Philip replies, that it is not suspended only because we cannot bear the uneasy sensations that would follow. On the same ground it might be affirmed, that we cannot voluntarily keep our hand in the fire, because no person would voluntarily submit to the pain that would follow. He has proved by experiment, that the heart will continue to beat after the Brain and Spinal Marrow have been both removed,* and that so far from the muscles

* Le Gallois himself had observed, that the heart contracted after crushing the Spinal Marrow, but he snpposed such contractions differed not only in degree, but were of *a different nature* from

owing their excitability to the Nerves, that they will preserve this property after it has been exhausted and destroyed by frequent irritation in the Nerves themselves. This tends strongly to prove the independent contractility of the muscles, and to place the opinion of Haller, in this respect, on stronger

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these by which the circulation was supported; and with them he classed those of the heart, when separated from the body, and also the contractions that may be produced in the voluntary Muscles for a short time after death. Dr. Philip, on the contrary, supposes all these contractions to be *of the same nature* as those produced in the natural functions, and differ only in degree: he has observed, that when the Spinal Marrow was crushed, the contraction of the heart was feeble and fluttering, becoming, especially in cold blooded animals, gradually stronger and more regular; but when the heart was separated from the body, the contractions were at first strong and regular, becoming gradually, and in the cold blooded animal very slowly, more feeble; and as for the voluntary muscles, they may be made to move the limbs for a short time after death, precisely as during life.

grounds than ever. He differs from Haller however, we have seen, in admitting that both kinds of muscles may be *influenced* through the Nervous system. Thus he allows that the heart may be affected by the passions, and may be excited by stimulants applied to the Spinal Marrow, as well as the voluntary muscles. Dr. Philips has also found that the heart may be excited through the Nervous system *for a longer time* than the voluntary muscles.

The stimulus that excites the voluntary muscles must be intense as mechanical stimuli ; and it must be applied near where the Nerves of the muscles are given off. The effects that follow it are *irregular* motions, and they principally occur at the moment the stimulus is applied.

The heart, on the other hand, obeys a much less powerful stimulant, as the chemical; but it must be applied to a considerable part of the Brain or Spinal Marrow; the heart is then excited, but never rendered irregular, and the excitement may generally be perceived as long as the stimulant is applied.

I have observed on a former occasion, (page 114), that if one side of the Cerebrum, Cerebellum, Pons Varoli, or Medulla Oblongata were compressed, paralysis would be produced on the opposite side. But if one side of the Spinal Marrow were compressed, it would be produced on the same side. The rule, as regards the Medulla Oblongata, has been stated cn the authority of Lorry, (Memoires des Savans Etrangers, 1760); its correctness has been doubted by Dr. Yellowly, and I find the experiments of Flourens have led to the opposite conclusion, namely, that compression of one side of the Medulla Oblongata produces its paralytic effects *on the same side,*

Thirdly, we now come to Dr. Philip's opinion that a third function of the Nervous system is to separate the different secretions from the blood. He conceives that this function is partly established by the influence which the mental emotions have over the secretions. Thus, affection of the mind excite tears; the desire of food causes an increased secre-

tion of saliva ; the flow of milk is suppressed by withdrawing the child from the breast; and disagreeable news will interrupt the process of digestion. The results of certain experiments have been also adduced in favour of this opinion. Mr. Brodie found the secretion of urine was suppressed by dividing the upper part of the Spinal Marrow, and in another set of experiments he found that the division of the Par Vagum prevented the secretion into the stomach, which would otherwise attend poisoning from arsenic. You will find in the works of Le Gallois a very complete history of the experiments in which these Nerves were divided: I shall here notice only these that relate to the subject of secretion. Vasalva had observed, that after division of the eighth pair of Nerves there were frequent attempts to vomit; a quantity of food was found in the Œsophagus, which he attributed to a difficulty of its reaching the stomach, and digestion was interrupted. Haller also observed, that digestion was interrupted by the operation, and similar results

were obtained in the experiment of Blainville, Le Gallois, Brodie and Philip.

Dr. Philip commenced by examining the process of digestion in an animal in which the Nervous system was entire. The stomach, he found as described by Sir Everard Home, to consist of two portions, forming an angle, which is best seen while digestion is going on. The Cardiac portion is to the Pyloric as two to one. The food contained in the Cardiac portion is largely diluted with fluid, while that in the Pyloric portion is more compact and dry. In the Cardiac portion the principal change occurs, and in this portion also the part next the stomach is considerably more digested than in the centre. In the Pyloric portion the food is of a more *uniform* consistence, but is dryer, as already observed, than in the Cardiac portion. Now Dr. Philip found that when a portion of the Par Vagum was removed, the food remained unchanged—the Gastric secretion was altered—there was frequent desire to vomit, owing to the previously digested part being propelled into

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the Duodenum, and the fresh part remaining in contact with the coats of the stomach;—and that the tendency to vomit caused an accumulation of food in the Œsophagus. Breschet and Edwards had observed, that digestion was interrupted by division of the Par Vagum, and they supposed that the cause was a paralysis of the muscular fibres of the stomach. Majendie, however, has found that the motions of the stomach remained after division of the eighth pair, and Dr. Philip has proved the same. Dr. Philip next argues, that the interruption to digestion could not be owing to the pain necessary for exposing the Nerves. This he proved by laying open the thorax in two animals. In the one he simply exposed and raised the Nerves; in the other he divided them: in the former case, the food was found digested, and in the latter, unchanged. The only reason, therefore, that can be assigned is, the alteration of the Gastric secretion, which implies, that either the *contraction of the secreting vessels*, or the *function* of secretion, must depend upon the Nervous influence.

In the second chapter of his Inquiry he has shewn, that the minutest vessels are independent of the Nervous influence, as they may be observed contracting in the web of a frog's foot after the Brain and Spinal Marrow have been removed, and the inference deduced accordingly is, that secretion is the result of the direct action of the Nervous power on the Blood, and is impeded when a portion of the Nervous influence is cut off.

Though some of Mr. Brodie's experiments have been adduced in favour of the Nervous theory of secretion, yet it appears from a passage quoted by Dr. Cooke, that Mr. Brodie conceives that the influence of the Brain and Spinal Marrow is not necessary to secretion generally, although particular secretions are subject to it. "In one of my experiments," says Mr. Brodie, "I divided and removed about a quarter of an inch of the anterior and posterior Crural and Sciatic Nerves of a dog, in the upper part of the thigh; the limb, of course, became immediately benumbed and paralysed. A wound was then made

in the leg, and the claws of all the feet were cut, so as to make them of the same length. The wounds suppurated, and healed as readily as if the Nerves had been entire. At the end of five weeks another wound was made in the same leg, which suppurated and healedalso. At the end of seven weeks I measured the claws of the four feet, and found that those on the paralysed limb had grown equally with those of the other.

"The experiment was repeated on guinea-pigs. and with the same results. In one of them the Tibia was broken, and the bone readily united.

"I have already mentioned," continues Mr. Brodie, "an experiment in which I removed the posterior part of the Spinal Marrow of a frog, so as to destroy the origin of the Nerves of the lower extremities. In this case the bones of one leg were broken; and when the animal was killed I found the bone united, partly by callous, partly by bony substance. It was evident that the power of forming new bony matter continued, notwithstanding the destruction of the

Nerves; and the circumstances of the union being incomplete, may be reasonably attributed to the animal being in a torpid state, and remaining apparently without nourishment for many months. "These experiments, and others of the same description, have led me to conclude, that the Brain and Spinal Marrow are not necessary to the animal secretions; at the same time, there can be no doubt, and a multitude of facts show, that certain secretions are very much under their influence; and a question may still remain, what properties the Nerves themselves may possess, independent of the Brain and Spinal Marrow, from which they have their origin?"

Dr. Alison, also, has stated several reasons for dissenting from this theory. His principal objections are, that the Gastric secretion may be deranged by the Lesions of other parts of the Nervous system besides the Par Vagum, which yet must be the principal medium of the galvanic influence to the stomach:—that secretion will take place where there is no Brain or Spinal Marrow, in the chick in ovo, and

in vegetables:—that in Dr. Philip's experiments the secretions, as those into the Bronchiæ, were increased instead of being diminished by division of these Nerves:—and that in Brodie's experiments, after they were divided and artificial respiration kept up, Carbon, which, according to Mr. Ellis is a secretion, was given out by the Lungs.

Dr. Philips replies to these objections, that the functions of the stomach depend—not entirely on the eighth pair, but also on the Spinal Marrow, and therefore, that the injury of this latter must affect its secretion; that the secretion is not suppressed, because it would be impossible to cut off the entire Nervous influence from any organ in a living animal; that cases, no doubt, have occurred, in which the secretions were performed without a Brain or Spinal Marrow existing, but if we concluded from these facts, that the secretions did not depend on the Nervous system, we must also conclude, that respiration does not, for animals have breathed without a Brain or Spinal Marrow; and lastly, that as the

Nervous system produces the secretions only by affording the Galvanic fluid, vegetables, for aught we know, may also have an apparatus for the production of this fluid.

I have already stated, that Dr. Philips supposes animal Caloric to be a secretion, depending, as the other secretions, on the Nervous system. Mr. Brodie had previously ascertained by experiment, that if respiration be artificially maintained in a decapitated animal, the changes from black to red blood will go on, but the power of generating heat will be lost: this led him to conclude, that the process depended on the Nervous system.

Le Gallois's experiments were, in some points, favourable to the chemical theory of Crawford. He observed, 1st, that animals in which artificial respiration was kept up, cooled slower than simply dead animals;—2dly, that in cooling they parted with more heat;—3dly, that the inflation of the lungs of healthy animals will reduce their temperature, and if continued long will ultimately destroy them by

cold;—and 4thly, that whatever impedes or embarrasses respiration, will diminish the temperature of the body. However, though he observed a very exact correspondence between the chemical effects of respiration, and the degree of heat extricated, yet he also found, that whatever weakened the Nervous power, diminished the power of producing heat, and therefore concludes, that the Nervous system is concerned in the production of heat, though not directly.

We have some pathological observations by Mr. Earle, that seem to favour the idea of this process depending on the Nervous system. He has observed cases of paralytic limbs, in which the pulse was good, and yet the temperature below that of the rest of the body; in such case he found its temperature could be raised by electricity.

Sir Everard Home supposes, that the power of producing animal heat depends on the Ganglionic portion of the Nervous system. His principal argument is, that all animals have a Nervous system,

but that those alone which have the power of evolving heat are provided with Ganglions.

Even if it were admitted, however, that the Nervous system was essential to the formation of animal heat, this would be only a step to the proof of Dr. Philips's opinion, that it is a secretion separated from the blood by the Nervous power, in the same manner as the other secretions. Dr. Philips was led to adopt this opinion by observing, (page 149,) "that while the destruction of part of the Spinal Marrow impedes the office of secreting surfaces, it also lessens the disengagement of Caloric." On the supposition of its truth, we should find that Galvanism being identical, according to Dr. Philips, with the Nervous power, should be able to separate Caloric from the blood, and accordingly, on making the experiment, Dr. Philips found, that if the wires of a Galvanic apparatus were placed in a cup of *fresh drawn Arterial* blood, its colour was changed to the Venous hue, and its temperature raised a few degrees. If a short interval elapsed between draw-

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ing the Arterial blood and applying the Galvanic influence, the change of colour took place, but heat was not extricated, neither was heat extricated when the Galvanic fluid was applied to *venous* blood.

I have stated that *the sensorial functions*, which form the next subject for consideration, cease with life, but that the Nervous functions remain for a short time afterwards. When volition ceases, respiration, which Dr. Philip conceives to be a purely voluntary act, must also cease, and the changes effected in the Blood by this function no longer taking place; the proper materials for secretion and nutrition cannot longer be supplied; the Nervous and Muscular solids, therefore, deviate from the state necessary for the functions of life, which at length cease in every part.

The Sensorial Functions are, in fact, two of the mental faculties, and they are treated of in Physiological works because they are essential to life. The superiority of the mental faculties of man over other animals has been attempted to be explained by a

variety of circumstances. Some, as Aristotle and Pliny, supposed the brain of man to be larger than that of any other animal: the elephant, however, forms an exception to this observation. In later times it was explained by a supposed fact, that man had a larger Brain in proportion to his body than any other animal: subsequent investigation, however, has shown, that the Dolphin, Seals, some quadrumana, and some animals of the mouse kind equal—and that some small birds even exceed man in this respect. Sœmmering has furnished us with another point of comparison, to which no exception has hitherto beeen discovered. He affirms, that man has a larger Brain in proportion to his Nerves than other animals.

The most remarkable characters of the human Brain are the great developement of the Cerebral hemispheres to which, as Mr. Lawrence observes, "no animal, whatever ratio its whole Encephalon may bear to its body, affords any parallel;"—its perfection in the number and developement of its

parts, so that there is no part in the Brain of any animal that is not in man;—the greater excess of its Medullary over its Cortical matter;—its more spherical form;—its greater excess above the size of the Nerves;—and the depth and number of its convolutions.

Magendie is said to be the first that observed a connexion between the number of the convolutions and the state of the intellectual faculties. This connexion is supported by the facts, that in any one species of animal the fœtal has fewer convolutions than the adult Brain; and in the cases of idiotcy, the number and depth of the convolutions is less than ordinary. Desmoulins supposes their use is to increase the extent of the Cerebral surfaces, on which extent he supposes the number and perfection of the intellectual faculties to depend (page 606). With a view to solving this question, the proportion between the different parts of the Encephalon has been noted; it has not, however, afforded any peculiarity constant to man. In the human subject the

Cerebrum is nine times greater than the Cerebellum; but there are animals in which it is fourteen times greater. The excess of the Brain above the Medulla Oblongata and Spinalis is greater in man than almost any other animal—the dolphin, however, is an exception.

Having thus examined the Nervous and Sensorial functions, we are naturally led to inquire if there be not a *sensorium commune*, or part of the Nervous mass in which sensations and perception take place, and from which volition and irritation are propagated to the Muscles. This, with the older writers, had nearly the same meaning as the enquiry concerning the seat of the soul. Laurentius, Chrysippus, and many others, however, did not confine the soul to the Nervous system, but supposed it to be diffused over the whole body. Marher, Haller, Hartley, and Prochaska, placed it in the entire of the Cerebro-Spinal mass; Descartes in the Pineal Gland; La Peyronie in the Corpus Callosum; Richerand in the Annular Protuberance; Willis in the Corpora

Striata; Sœmmering in the waters of the Ventricles: Digby in the Septum Lucidum; and Locke and Newton at that part of the Brain in which the Nerves were supposed to meet. Experiments, however, were afterwards made, which showed that these functions had not any common seat, but that different parts were the seat of different faculties, so that latterly, instead of inquiring into the seat of the soul, Physiologists have been employed in ascertaining in what part of the mass each of these faculties resided? These investigations were pursued in different ways by different Physiologists. Some have preferred Anatomical research; thus, to find the seat of perception, they endeavoured to trace all the Nerves to some one part of the Brain. Others, as Rolando, Majendie, Flourens, Fœdera, &c. proceed by Mutilation or Physiological experiments. Lallemand and others, by Pathological observations; and Gall and Spurzheim by comparing the relations between the developement of different parts and the exhibition of particular functions. So great, how-

ever, is the difficulty of the subject, that notwithstanding the talents, assiduity, and integrity of the individuals engaged in those investigations, and the various modes that have been employed, the greatest contrariety may be observed in the conclusions at which they have arrived. The complete consideration of these four methods would include the pathology of Nervous system, Phrenology, &c. and would far exceed the limits of a work like this. I shall, therefore, merely notice a few of the older opinions, and afterwards briefly detail the results of the most remarkable experiments in modern times to elucidate this subject.

Galen supposed that the Nerves of sensation arose from the Brain, and those of motion from the Spinal Marrow. Willis thought the Nerves arising from the Brain were distributed to the voluntary Muscles, and those from the Cerebellum to the involuntary Muscles. The very contrary of this is the opinion of Haller; he supposes that the moving and feeling power is sent to the vital organs by the Cerebrum,

and to the parts subject to the will by the Cerebellum. Others have supposed the Membranes to be the seat of sensibility. Even Magendie thinks this an opinion deserving farther investigation, having observed a case in which a portion of the Spinal Marrow was destroyed, and no communication left between the upper and lower parts except by the membranes, and yet paralysis of the lower extremities did not occur.

Flourens was led, in the course of his experiments on the seat of motion and sensation, to conclude, that in every voluntary movement there are three essential phenomena, viz.—volition, which has its seat in the Hemispheres; co-ordination, or regulation of the movement, which has its seat in the Cerebellum; and excitation of the contractions, (which I have elsewhere termed irritation, and) which has its seat in the Optic Tubercles, Medulla Oblongata, the Spinal Marrow, and Nerves. He supposes that the power of willing, feeling, and perceiving, constitute but *one* faculty, and reside in *one* organ, viz.—the

hemispheres of the Brain. You will perceive, therefore, that he differs from Wilson Philip, first, in making sensation, perception, and volition, one faculty instead of three; and in making voluntary motion to consist of three phenomena instead of two, by adding a faculty of regulation or co-ordination to volition and irritation. Rolando had previously made experiments similar to those of Flourens, and with nearly similar results. The principal point in which they differ, is, that Flourens makes the Cerebellum *the regulator* of the voluntary motions, whereas Rolando considers it as a voltaic pile, and makes it *the source* of these motions.—See Magendie's note to Rolando's paper in the Journal de Physiologie.

The opinion of Magendie differs materially from that of Flourens. He infers from his experiments, that the seat of the sensations is neither in the Brain proper, nor in the Cerebellum. "Remove," says he, "the hemispheres of the Brain and Cerebellum in a mamiferous animal; endeavour then to ascertain if it can experience sensations, and you will easily know

that it is sensible to odours, savours, sounds, and sapid impressions. In the enumeration I have just given," continues this author, "I have not mentioned sight; because it is in fact quite a peculiar case. It results from the experiments of Rolando and Flourens, that vision is abolished by the abstraction of the hemispheres. If the right hemisphere is removed, it is the left eye which ceases to act, and *vice versâ.*"

The experiments of Majendie, on the Cerebellum, have been followed by extremely interesting results. He found that when a vertical section was made on the middle line of the Cerebellum of a rabbit, the eyes were agitated, and appeared starting from their sockets. The animal lost the power of balancing itself with precision, and was thrown alternately to right and left, and the fore legs were extended forwards, as if the animal was in the act of receding. When the vertical section divides the Cerebellum unequally, so as to leave the Crus and one-fourth of the Cerebellum to the right side, and the other Crus

and three-fourths of the Cerebellum to the left, the animal rolls towards the injured side, and continues revolving incessantly on its long axis; the right eye in this case is observed to be directed downwards and forwards, and the left upwards and backwards. The revolving motion of the animal may be then stopped, and the eyes made resume their natural direction by a similar section through the Cerebellum on the left side. The revolving motion may also be produced by division of the Crus Cerebelli of one side, and afterwards stopped by dividing the Crus Cerebelli of the opposite side. It is to be remarked, however, that if this motion be produced by division of the Cerebellum of one side, the subsequent division of the *Crus* of the opposite side will not put a stop to it, but the animal will now commence rolling towards the opposite side, viz. that on which the Crus was divided. The case of a shoemaker is related by M. Serres, who, after a fit of drunkenness, commenced revolving on his axis, and even when placed in bed manifested this tendency till he died

On dissection, an extensive lesion was observed in one of the peduncles of the Cerebellum. In the third volume of the Journal de Physiologie, you will find a paper by Fœdera, in which are detailed a number of interesting experiments on the Cerebellum. It appeared that lateral pressure on the Cerebellum did not produce any sensible effect, and deep wounds of the Cerebellum produced paralysis on the *same side* of the body, a result which contradicts the previous opinion on this point.—See page 114.

The distinction of the functions of this system into nervous and sensorial, have rendered inquiry necessary concerning the seat of each. Le Gallois supposes the former to reside in the Spinal Marrow, and the latter in the Brain. Dr. Philips conceives, that though these are the principal seats of these two sets of functions, yet that they are not exclusively so; The rabbit, after the Brain is destroyed, will move one limb when another is wounded; shewing, that it preserves the sensorial power, so as to receive im-

pressions from one set of Nerves, and communicate them to another: and again, Nerves proceeding wholly from the Brain exhibit the phenomena of the Nervous power, properly so called. Flourens, we have already seen, makes perception and volition to reside in the Hèmispheres of the Brain, and therefore may be said to place the sensorial functions in these masses.

Having thus ascertained that the Cerebro-spinal Mass is the part to which the sensations are transmitted, and from which volitions are propagated, and that the Nerves are the agents employed in both cases, our attention should next be directed to the Nerves themselves. Concerning these, our first enquiry will be whether the same Nerve may be employed in *any* of the preceding functions, or whether different Nerves have different functions, so as to lead to a useful classification of them; 2dly, we will inquire into their structure, course, relations, &c. and lastly into their Modus Operandi.

First, it had not escaped the observations of the

older physicians, that there were different Nerves employed for the different functions. Thus the second Nerves were obviously Nerves of sense, and the third were known to be Nerves of motion. Erisistratus had observed, that paralytic limbs were not equally deprived of sense and motion, and he naturally inferred, that they were supplied by different kinds of Nerves, which had suffered in different degrees. The terms Mollis and Dura applied to the divisions of the seventh pair of Nerves, refer to the old doctrine of Galen, who supposed the Nerves of sense were soft, and those of motion hard. It was next observed, that the same Nerves in some instances contained the filaments both for sensation and motion: we find this opinion distinctly stated in most of the works on Anatomy, from a very early date to the present period. The origin of the different kinds of filaments, from peculiar tracks in the Cerebro-spinal Mass, is the discovery of modern times. Spurzheim, in 1815, suggested the idea, that the Spinal Nerves might contain filaments both for

sensation and motion, as they rose from the Spinal Marrow in separate bundles. Mr. Charles Bell was the first that proved, in a paper in the Philosophical Transactions for the year 1820, that the posterior roots of the Spinal Nerves are the filaments for sensation, and the anterior those for motion. His subsequent inquiry confirmed this opinion, and led him to the discovery of an additional order of Nerves, which he terms respiratory.

According to Mr. Bell the Spinal Marrow consists of three columns, viz. an anterior for motion, a posterior for sensation, and a middle column giving origin to the respiratory Nerves. The Anatomical relations of the middle column have been described at page 105. It does not extend into the Brain, as the anterior and posterior do, because, acccording to Mr. Bell, its functions are not dependent on the sensorium, as those of the anterior and posterior column are.

Now the Nerves arising from these columns, or from their prolongations into the Brain, he divides

into two classes;—the first are *the regular Nerves.* These all arise by double roots, one from the anterior, and the other from the posterior column. *The anterior roots* are smaller, without Ganglions, when rritated are insensible, but produce contraction in the muscles they supply, and when divided these Muscles lose the power of contraction. *The posterior roots* have the opposite characters; they are larger, interrupted by Ganglions, acutely sensible, and when divided, the parts they supply lose their sensibility; but, if Muscles, preserve their power of contraction. To this class are reduced the fifth and tenth Cerebral Nerves, and all the Spinal Nerves. Now it is sufficiently clear, that the Spinal Nerves arise by two roots, and the experiments of Majendie, Mayo, and others, confirm the statement of Mr. Bell, that they possess the other characters assigned them above: but as to the fifth and tenth, though Sœmmering has observed the analogy of fifth to the Spinal Nerves, and the tenth has been considered as a Spinal Nerve by a great number of anatomists;

it may be necessary to point out their resemblance in a few words, and explain Mr. Bell's reasons for classing them as he has done.

I have shown, in describing the origin of the fifth Nerve, (page 87,) that it arose by two roots;—a smaller from the Crus Cerebri, which is a production of the anterior column of the Spinal Marrow, and a larger, which may be traced to the vicinity of the Restiform body, or posterior column of the Spinal Marrow. "The one," says Mr. Bell, "is the muscular Nerve, the other is the sensible Nerve: on this last division the Gasserian Ganglion is formed. But we can trace the Motor Nerve clear of the Ganglion, and onwards, in its course to the muscles of the jaws, and so it enters the Temporal, Masseter Pterygoid, and Buccinator Muscles," while the sensible Nerve supplies the head, face, &c. with sensation. It moreover resembles the Spinal Nerves by its communication with the Sympathetic system, as with the Lenticular and Spheno-palatine Ganglions. Its analogy with the Spinal Nerves is far-

ther proved by experiment, for irritation of the anterior or motor division of it caused the jaws to snap while the division of the Ganglionic portion destroyed the sensibility of the parts supplied. Mr. Bell has noticed the points of resemblance; but there are points in which it differs from the Spinal Nerves—such as that its Ganglion, (the Casserian,) is softer than those of the Spinal Nerves,—that the anterior and posterior roots do not unite, and that the Sympathetic communicates with its three divisions. As for the tenth Nerve, I have, at page 137, enumerated Bichat's reasons for classing it with the cerebral Nerves. Mr. Bell however conceives, that it "is in constitution a Spinal Nerve; that is, it has a double root or ganglion on its posterior root, and its distribution is similar to the Spinal Nerves, quite unlike those of the Encephalion."—page 27.

The second set of Nerves arising from these columns are, according to Mr. Bell, *the irregular Nerves:* these are all *single* in their origin, that is, arise from only one of the columns. Those that

arise from the anterior column are Nerves of motion; they are the third, sixth, and ninth: those that arise from the posterior column are Nerves of sensation; to this I can reduce only the Auditory, for Mr. Bell has taken no notice whatever of the first or second Nerve in his classification.* Those that arise from the middle column Mr. Bell terms Respiratory Nerves; and since this class of Nerves was discovered by Mr. Bell, it will be necessary to say a few words in explanation of their nature and functions.

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* This has been also observed by the different reviewers of Mr. Bell's work; the following paragraph is extracted from the Quarterly Journal of Foreign Medicine:

"It will be remarked, that Mr. Bell has not arranged the two first Cerebral Nerves in his second class, though in so far as they arise from one column only, they may, equally with the last mentioned, be called irregular. More than this, however, they appear to present a contradiction to his peculiar views, which we are not aware that he has explained: they are Nerves of sensa-

The Diaphragm is the principal Muscle employed in ordinary respiration, and is supplied through the Phrenic Nerve with filaments from the respiratory column. Other Muscles of the trunk are also employed, either in forced respiration, or in some of the modes of respiration, as sneezing, hiccough, &c.: thus the Trapezius is observed to sympathize with the Diaphragm, and contract in sneezing. The Sterno-mastoid is employed to raise the Thorax, and so is the Serratus Magnus; but before these act the Trapezius must fix the head in the former case, and the scapula in the latter. Now many of these Mus-

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tion, and yet they arise from what, according to Mr. Bell, must be considered as a prolongation of the anterior column of the Spinal Marrow; in other words, two Nerves of sensation arise from a column which is stated to give origin exclusively to the Nerves of motion. The same difficulty does not present itself with regard to the Auditory Nerve, which actually arises from the posterior column."

cles have Nerves supplying them for the purpose of ordinary contraction, but they have, moreover, certain Nerves which combine their motions with the respiratory motions. These Nerves are termed *the Respiratory Nerves,* and include the pathetic, facial, glosso-phragyneal, vagum, spinal accessory, posterior thoracic, and phrenic. In page 92 of Mr. Bell's work, the ninth of Willis, or lingual, is included among the Respiratory Nerves; I apprehend this is a mere oversight, it has been copied, however, into the work of Magendie and Desmoulins. The Respiratory Nerves are distinguished by the following characters: they do not arise by double roots, they have no Ganglia on their origin, and come off from the Medulla Oblongata and upper part of the Spinal Marrow. Dr. Bostock represents them all as involuntary, but Mr. Bell distinctly states, that the voluntary motions of the lids depend on the Facial, which is a Respiratory Nerve.

But the Respiratory Nerves are not distributed merely to the Thoracic Muscles; other Muscles,

though distant, have certain sensibilities depending on a supply of Respiratory Nerves, by which they combine in action with the proper Respiratory apparatus. Thus the stomach is supplied from the respiratory column by the Par Vagum, and accordingly we find, that irritation of it produces hiccough and vomiting; and in conformity with this doctrine Mr. Bell observes, that comparative Anatomy proves that the Par Vagum is not essential to the stomach, and only exists where there are heart and lungs to associate with a muscular apparatus of respiration.

The facial, also, is a Respiratory Nerve, and serves to associate, on some occasions, the actions of certain Muscles of the face with those of the thorax; this is observable in the distention of the nostril of the post-horse, when respiration is accelerated by exercise. The division of this Nerve gives no pain;* but touching it convulses, without pain, all the Muscles of the face, and dividing it destroys the expression

* This is denied by Magendie and Desmoulins.

of the countenance and the respiratory motions of the parts supplied, so that in laughing (a mode of respiration) the sound side of the face is in motion, but that on which the Nerve was divided remains placid.

The fourth, or pathetic Nerve, is the only respiratory Nerve remaining to be noticed: it is distributed to the superior oblique Muscle of the eye. Its function, according to Mr. Bell, is to produce *relaxation* in this Muscle, in consequence of which the eye is left to the other involuntary Muscle, (the inferior oblique,) and the Cornea is elevated, and this elevation of the Cornea is observed to accompany certain respiratory motions, such as sneezing. This subject will receive farther consideration when we come to examine the contents of the orbit.

The second subject of inquiry is the structure and properties of the Nerves. On examination we find them composed of a number of delicate medullary filaments, embraced by a fine membrane, or Neurilemma; the filaments are collected into Fasciculi,

each of which is surrounded by a membrane of a similar nature; and the Fasciculi are themselves collected together to form the Nerve. The size of the filaments do not depend on the size of the Nerve; thus the filaments that compose the Sciatic are smaller than those of the Brachial Nerves, except the Median. According to the observations of Bichat the Nervous filaments unite with each other, so that a Nerve contains an interlacement of filaments, nearly resembling the Plexuses formed by the Nerves themselves. There is this difference, however, that the Plexuses formed by the Nerves are produced by *fasciculi* separating from one Nerve and uniting to another; but in the interior of a Nerve the interlacing or Plexus is produced by a similar disposition of the *filaments* which separate from one Fasciculus and join another. In this manner Bichat found that the filaments which above composed the external Fasciculi of the Sciatic Nerve, entered into the composition of its central Fasciculi inferiorly.

In some situations the Nerves have a flattened form, as the Sciatic. In others they appear cylindrical. Sœmmering, however, has made the same observation respecting these that Hunter did on the Arteries, viz. that they increase in size as they are traced from their origins to their terminations, and are therefore conical in their form.

In their course *within the Cranium* the different membranes of the Brain have different relations to them; thus *the Dura Mater* accompanies them to their exit from the Cranium or Spinal Canal, and is then lost in either the cellular tissue or Periosteum without. The Optic Nerve, however, has its fibrous canal continued around it to its termination in the eye.

The Arachnoid usually surrounds them near their origin, and is reflected where they receive their fibrous covering. In some, however, as the second and sixth, the serous sheaths enter for a short distance within the fibrous canal before it is reflected.

The Pia Mater is continuous with the Neurilemma,

of which I shall have occasion to speak more fully just now. I shall here only observe, that the Olfactory appears to want a Neurilemma in the Cranium, as also the Optic, until its junction with the Nerve of the opposite side.

The Nerves, *after their exit from the Cranium,* take their course generally through cellular intervals, or Axillæ, as they are termed. The shortest Nerves are those for the head; the longest are distributed to the extremities. In their course they give off filaments, generally forming acute angles with the continued trunks: the shortest filaments are given off first, and the longest run the whole course of the Nerve. The Nerves terminate either in the different organs or in Anastamosis. Of their mode of termination in organs, we have no very precise knowledge. Dr. Monro observes, that " the Nerves sent to the organs of the senses lose their firm coats, and terminate in a pulpy substance. The Optic Nerves are expanded into a soft tender web, called the Retina. The Auditory Nerve has scarce the

consistence of mucus in the Vestibulum, Cochlèa, and semicircular Canals of each ear. The Papillæ of the nose, tongue, and skin are very soft. The Nerves of Muscles can likewise be traced till they seem to lose their coats by becoming very soft; from which, and what we observed of the sensatory Nerves, there is reason to conclude, that the Muscular Nerves are also pulpy at their terminations, which we cannot indeed prosecute by dissection. It would seem necessary, that the extremities of the Nerves should continue in this soft flexible state, in order to perform their functions aright: for in proportion as the parts become rigid and firm by age, or any other cause, they lose their sensibility, and the motions are more difficulty performed." To the same effect Mr. Herbert Mayo (Physiology, p. 227) observes, that as they arise in grey substance from the Brain, so they also terminate in an expansion of grey Nervous substance, wherever they admit of examination.

In many situations we may observe Nerves

communicating with other Nerves, and Bichat has observed a curious fact, that the lower the Nerve the more frequent the communication. Thus the first, second, and Auditory do not communicate at all; the third, fourth, and fifth have fewer communications than the eighth and ninth, and these last less than the Spinal Nerves which form a number of Plexuses.

The Anastamoses of Nerves must not be confounded with a relation of contiguity, as seen in the Plexuses or between the Vidian and facial. Nerves have fewer Anastamoses than Arteries. Some of them Anastamose with the Sympathetic, as the *Dorsal*; others with the Cerebro-Spinal of the opposite side, as the Facial; others with those of the same side, as the ninth with the Cervical; and others with branches of the same nerve, as the different divisions of the fifth with each other.

The above description is applicable to the greater number of the Nerves; there are some of them, however, which have peculiar characters, as the Olfac-

tory, Optic, Auditory, Pneumo-gastric, and Intercostal, and will therefore receive separate consideration hereafter.

The Nerves are resolvable into two principal parts, a medullary and membranous.

The Medullary portion appears to be of the same nature as the medullary substance of the brain. It is dissolved by the action of alkalies, and of this property Reil availed himself to separate it from its Neurilemma, and examine the latter more completely.

The Neurilemma is continuous with the Pia Mater, and forms canals or sheaths for each of the Nervous filaments. Around the second Nerve it forms a general envelope. There does not appear to be any foundation for the opinion once entertained, that the Neurilemma secretes the Medullary portion of the Nerve; some of the Nerves, as the Olfactory, and commencement of the Optic, have no Neurilemma, and the Pia Mater with which it is continuous does not secrete the substance of the Brain. Its use is to

form an envelope for the Nervous filaments, and a stratum for the ramification of its vessels. Its strength is exceedingly great, and it is owing to the larger proportion of the membranous part in the Nerves of young subjects, that they are so much more resisting than in adults. Besides the Neurilemma and Medullary matter, we have cellular substance both around the Nerve and between its Fasciculi. In this latter situation we occasionally find fat, as between the Fasciculi of the Sciatic Nerve; in the former it is very commonly found, except in the Cranium, where the cellular substance is wanting.

The Nerves are supplied with vessels from the neighbouring trunks: after entering, they creep between their Fasciculi, and then, after subdividing, between their filaments. Under certain circumstances these vessels become extremely large; Boyer dissected a subject operated on by Dessault, for Popliteal Aneurism ten years before, and found the Artery in the Sciatic Nerve as large as the Radial at the wrist. The Optic Nerve is peculiar in having

a blood vessel passing directly through its centre or axis. The blood of these vessels is returned by corresponding veins. Bichat, however, has observed, that they resemble those of the Brain in not entering at the same place as the Arteries. The existence of exhalents and absorbents in Nerves cannot be proved by dissection, but is inferred from their nutrition.

The Properties of Nerves are either vital or physical. The vital properties are sensibility and contractility. All Nerves possess *organic* sensibility and many of them possess *animal* sensibility. Mr. Bell has observed, that the posterior roots of the Spinal Nerves, and, generally speaking, the Nerves employed in transmitting sensations are themselves very sensible. This does not at all follow, however, as a necessary consequence; and Mr. Bell himself observed on one occasion, as did also Magendie, that irritation of the Retina did not produce pain. The Nerves of motion do not, in general, produce pain when irritated, but Mr. Bell's experiment, in

which he found the Facial Nerve insensible to pain, is contradicted by Magendie and Desmoulins. Irritation of the Nerves belonging to the sympathetic system does not produce pain. The sensibility in these cases is supposed, by Bichat, to reside in the Medullary and not in the Membranous part of the Nerve. He also found that it may be exhausted by frequent irritation, and renewed after an interval of rest. Nerves possess no vital contractility, except what is necessary for their nutrition—what Bichat would term insensible organic contractility.

If from vital we pass to its physical properties, we find it has little extensibility, and still less contractility of tissue, so that when a Nerve is divided it does not retract, but still preserves its orignal situation.

It may be here inquired, whether a Nerve once divided will join again, so as to allow the Nervous power to be transmitted through the reunited part: this has been determined in the affirmative, by the experiments of Haighton. On dividing the Vagum

of both sides, the animal constantly died in consequence. If the Vagum of one side only was divided, the animal appeared to be recovering, but it died immediately if the Vagum of the opposite side was divided before the former united ; but if the Vagum of one side was divided, and allowed to reunite before that of the opposite side was divided, the animal recovered notwithstanding. The animal (a dog) employed in this last experiment he kept for several months afterwards in good health, and then divided the Vagum of both sides below the reunion, when he found that the animal died in consequence : this he considered an Experimentum Crucis. The reunited part, I may here observe, constantly presents a swelling resembling a Ganglion.—*See* Flouren's Experiments in the Appendix.

The third subject for inquiry is *the Modus Operandi of the Nerves.*

There are two principal hypothesis on this subject: the first is, that they act by vibration, and the

second, that they act by a fluid propagated along the Nerves.

The principal arguments in favor of the Nerves acting by vibration are, that the impressions remain after the exciting cause is removed, and terminate in the manner vibratory actions do. 2dly, That the sensation of sight and hearing are produced by certain undulations of the air acting on their respective organs. Add to this, that sight may be produced not only by a ray of light, but by electricity, and mechanical causes, as a blow on the eye.

Though the idea that the Nerves vibrated like the strings of a musical instrument appears so absurd, yet it has been maintained by many Physiologists of former times, and has been deemed worthy of serious refutation, as by the following arguments :—

1st, That the Nerves are not tense, and are therefore incapable of vibrations. 2dly, That the softness of their extremities would preclude the idea of such tension. 3dly, That if tense, a Nerve should always convey the same idea unless we supposed it to alter

its texture, length, or tension each time a different object is applied, which it is presumed no one would undertake to prove. 4th, That from the contiguity of different Nerves the vibration must be communicated, and therefore we would have the notion of the object being applied at all the different parts at which the extremities of the fibres terminate. 5thly, That the sensations are blunted, and the contractions of the muscles are weaker in old age when the Nerves are most elastic: and 6thly, that the Ganglia that are found in their course would greatly interfere with such action.

There is another sense, however, in which the doctrine of vibration has been maintained, and in which the glaring absurdities implied in the preceding opinion have been avoided. According to this hypothesis sensation is produced by the agitation of a certain fluid pervading the Nerves. This is the doctrine of Newton, Hartley, Priestley, Blumenbach, Young, Le Gallois, &c. They are not all, however, agreed upon the nature of this fluid; some, as New-

ton, consider it an elastic aether: others, as Young, suppose it to be the electric fluid. For a fuller account of this theory I must refer you to Hartley's works by Priestly, Newton's Optics, Belsham's Elements of the Philosophy of Mind, Young's Medical Literature, Elliotson's Blumenbach, and Legallois's Works.

Le Gallois supposes, that throughout the whole extent of the Nerves there is a secretion of a peculiar principle. "This principle once produced, subsists by itself, and after the entire cessation of the circulation, like that of the Brain and Spinal Marrow, but for a longer time. I had supposed that it was through the intervention of the principle of the Nerves that the Brain and Spinal Marrow acted on the different parts of the body, not by transmitting their own principle, but by agitating that belonging to the Nerves, nearly in the same way as sound is transmitted by the air. To prove the accuracy of this conjecture, it was necessary to find a Nerve easily insulated for a certain extent, and presiding over some function, the interruption of which would

be sudden and well marked, as soon as the Nerve ceased to perform its own. I selected the eighth Nerve of young cats. We will find hereafter that the ligature or section of these Nerves, in animals, causes suddenly all the symptoms of violent suffocation. In insulating them in the greatest part of the neck, and destroying the vessels which repaired to them, I had hoped, if my conjecture was well founded, that as soon as the principle with which they were pervaded at the moment of dissection, would be exhausted, the animals would suffer the same suffocation as if these Nerves had been tied or cut. But I in vain repeated this experiment several times: the result never answered my expectation. Respiration was not sensibly deranged; whereas dividing them an hour or two after their insulation always produced suffocation. I do not, however, entirely abandon this conjecture, for cats have short necks, and it is impossible to separate the Par Vagum throughout this region. It is possible that the secretion which still continues in the head and chest,

where the vessels are uninjured, may extend to the dissected portion."

The second opinion is, that the Nervous filaments are delicate tubes conveying a subtle fluid. In favour of this opinion is urged the great vascularity of the Cortical substance of the Brain—the fibrous texture of its Medullary part—and its striking analogy in structure, with other Glands, as the kidney. Experiments have also been made with a view to prove it. Dr. Monro states, that if you expose the Phrenic Nerve of a dog, and alternately compress it, and leave it free, you will find a corresponding paralysis or motion of the Diaphragm. If while it is compressed, and the muscle at rest, you slide your fingers gently along the Nerve, to transmit the fluid between your finger and the Diaphragm downward, the Muscle will act again for a short time, and then cease.

In this way motion was supposed to be easily accounted for by the afflux of the Nervous fluid to the Muscle, but there appeared to be considerable

difficulty in explaining how sensation was produced. Some supposed it was by a reflux of this fluid towards Brain in the same Nerves that conveyed it from that organ. Others, as Monro, snpposed the Nerves to be constantly full of the fluid, and that sensation was produced by an interruption to its passage, which was felt in the Brain. Others, that there were two sets of Nerves, effluent and refluent; the former employed in motion, and the latter in sensation; while others were reduced to admit both theories, supposing the Nerves of sense acted by vibrations, and these of motion by the propagation of a fluid.

The principal arguments against the existence of a Nervous fluid are the circumstances, that Nerves do not swell above a ligature, nor do we perceive any fluid issuing from the extremity of a divided Nerve: but it has been justly observed in reply to this, that neither do we find the fluids circulating in the coats of a Nerve manifesting themselves in this way, though there can be no doubt of their existence.

Dr. Bostock thinks that Wilson Philips' experiment, in which the Nervous power was transmitted across the interval, separating the extremities of a divided Nerve, is sufficient to refute *both* these hypotheses. Another objection against the theory of a Nervous fluid is, that we cannot with microscopes observe any canal in a Nerve; but though modern observations, as those of Bogros, are in favour of the existence of canals in the Nerves, yet such structure is not at all necessary to the theory, for fluids, as Caloric and the Galvanic fluids may be propagated along solid bodies.

These considerations naturally lead us to an inquiry into the nature of the fluid transmitted, which was formerly termed *the Animal Spirits.* By the animal spirit Galen understood a subtle fluid, which was transmitted through the Nerves to the different parts that move and feel. He supposed it to be generated from the vital spirit which was itself formed by the Heart and Arteries; having undergone certain changes in a vascular net-work, which he

terms the wonderful net-like Plexus, it is finally elaborated in the Ventricles, and thence distributed over the body. Descartes supposed the animal spirit to be secreted in the cortical substance of the Brain, and transmitted by its Medullary portion.

An old hypothesis has been lately revived by Dr. Philips, namely, that the Nervous is identical with the Galvanic fluid. In favour of this opinion have been urged—the subtlety of the electric fluid—its velocity—its action on the Muscles through the Nerves—that substances which conduct electricity conduct the Nervous fluid—that those which are not conductors of electricity are not conductors of the Nervous fluid, (Valli)—that the involuntary Muscles which do not obey the Nervous influence are also unaffected by Galvanism*—that a voltaic

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* It has been since proved, however, that the involuntary Muscles may be excited by *both* the Nervous and Galvanic fluid.—See Wilson Philips's Experiments on the first head; and on the

pile may be formed by alternate strata of Muscle and Brain, (Lagrave)—that many animals, as the Torpedo, Gymnotus Electricus, &c. can give at pleasure a shock resembling the electric. The Torpedo (says Dr. Good) is endued with organs which have a close resemblance to the voltaic pile, and if the structure be injured, by division of its Nerves, the torpifying effect is lost.

Doctor Philip, in arguing on this subject, maintains, first—that the Nervous power is an inanimate agent. His reasons for this opinion are,—1st, that its actions, as secretion, resemble in the most exact manner many chemical processes; 2dly, that inanimate agents may be substituted for it, as any irritating body will cause the Muscles to contract; 3dly, it may be made to reside in an unorganized body:

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second, see Bostock on Galvanism, Bichat sur la Vie et la Mort. Paris Medical Jurisprudence, vol. ii. p. 32, and Park, Quart. Journ. vol. ii, p. 233.

this fact appears from one of his experiments, in which the vagum was divided, and yet the Nervous power must have crossed the interval between the divided extremities of the Nerves, conducted by moisture or some interposed body, since the gastric secretion continued unaltered till a portion of the Nerve was removed. Dr. Philips having thus satisfied himself that these fluids agree in being both inanimate agents, and having also proved that the Galvanic fluid is capable of performing the three functions of the Nervous fluid, viz. exciting the Muscles*, transmitting impressions, and separating the secretions, (see Dr. Philips's work, 126, et seq.) next proceeds in his argument, that we

* Dr. Edwards is of opinion, that Muscular contraction is produced by electricity evolved by the contact of the Muscular fibre and Nerve, and he has found that the contractions cease if the Nerve be made to communicate with a good conductor.—Annales des Sciences Naturelles, May, 1825.

are therefore reduced to the necessity either of admitting that these fluids are identical, or of maintaining that two fluids agreeing in every instance in which we can compare them, are nevertheless different.

The principal objections that have been urged *against Dr. Philips's Hypothesis* are—that though the galvanic fluid may excite muscular contraction as well as the nervous fluid, yet that similarity of effect does not imply similarity of cause—that no proof has been offered that it is capable of conveying sensations—that secretion is not proved to be a function of the Nervous system—that the only secretions it has been affirmed to produce are, the Gastric Juice, and Caloric ; but it appears, that in the former case the Gastric secretion *is not suspended* by dividing the Vagum, and in the latter, the only consequence deducible from Dr. Philips's experiment (Inq. p. 187,) is, that the Galvanic fluid exerts a chemical action more readily on Arterial than Venous blood—that as the Sensorial functions cannot be supposed to be performed by this fluid,—and as the

sympathetic Nerve will not, *(they suppose)* transmit it, we must either suppose, what is highly unlikely, that the Cerebro-Spinal mass performs its functions by a multiplicity of agents, or that electricity is not the agent employed in the Nervous functions. Lastly, in a majority of animals we can find no apparatus for preparing this fluid. These objections may weaken, but they do not refute the hypothesis.

There is a class of Nerves which I have not yet spoken of, because, being distinguished by peculiar characters they seem to deserve a separate consideration. I allude to the Nerves belonging to the *Sympathetic system.* This system consists essentially of Ganglions, and the connecting filaments with their branches.

The Ganglions are all deeply situated, and the majority are found along the sides of the spine. Externally they present a reddish grey colour, and are embraced by a layer of condensed cellular tissue. When divided they present appearances that have been variously represented by different writers.

Bichat describes the section of a Ganglion as homogeneous in its appearance. Scarpa found the Nerves continued through the Ganglions, and their filaments related as those in a plexus. Besides this, he observed a peculiar substance interposed between the filaments, which he supposed, particularly in fat people, to be of an adipose nature. Lobstein also observed this substance, but terms it gelatinous.—Spurzheim conceives them to be composed principally of grey substance, having the same use as the grey substance of the Brain, &c. Their size varies exceedingly, as we find by comparing the superior cervical Ganglion with the lenticular. Their size does not depend on the size of the filaments given off: in the cervical region the Ganglions are large, and the filaments small,—the reverse may be observed in the dorsal region. The Ganglia are well supplied with arteries from the neighbouring trunks, and their blood is returned by corresponding veins.

The Nerves of this system are distinguished from the Cerebro-Spinal Nerves by their minute-

ness, their reddish colour, their arrangement in Plexuses around the Arteries and Vena Porta,* their distribution to parts not under the control of the will, † and their comparative insensibility, in which respect they agree with the Ganglions. By many

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* In this respect the Vena Porta resembles the Arteries, and differs from the other Veins. This fact is considered favourable to the opinion that Vena Porta is for the purpose of secreting the bile. It has been conjectured that other Veins owe their vital actions to the sympathetic filaments surrounding their minute Arteries, as no others can be traced to them.

† Sympathetic filaments are sent however to some of the Muscles under the control of the will, as the Rectus Capitis Anticus, Longus Colli, Intercostals, Diaphragm, &c. And on the other hand, cerebral Nerves form the principal supply of some involuntary Muscles ; as the Æsophagus, Stomach, &c. The last are amongst the Nerves that Mr. Bell traces from a fasciculus, *not extending into the Brain proper, nor communicating with the Sensorium*; this is probably the reason they are involuntary as well as the sympathetic.

writers this system is represented as *entirely* devoid of sensibility, thus: Majendie informs us that a Ganglion is cut, or torn out without the animal appearing at all conscious of the injury. "I have often," he observes, "made those attempts on the cervical Ganglions of Dogs and Horses; but similar operations on the Cerebral Nerves, would have produced the most dreadful torture. Should all the Ganglions of the Neck be removed, and even the first Thoracic, yet no sensible derangement would follow, not even of the parts into which their filament can be traced." These circumstances have induced Majendie to ask if they be Nerves at all! He is not correct, however, in supposing they have no sensibility, though it is difficult to exhibit it. Haller observed that irritating the hepatic plexus of a dog excited pain, and we will find hereafter that a similar effect was produced by the application of Galvanism to the semilunar Ganglion of a young cat, in the experiments of Dr. Copland.

Now, before we attempt to inquire farther into the

nature of this system, it may be necessary to answer Majendie's question, and assign a reason for believing them to be Nerves. First, They anastamose with the dorsal Nerves. Secondly, They resemble them in structure: Bichat and others have found them composed of filaments, and Bogros discovered a canal in the interior of each filament. Thirdly, Though they have little sensibility, yet, I have shown sufficient authority for believing they are not altogether without it, and many of the Nerves of animal life are as insensible on irritation. Fourthly, —When divided, they re-unite like those of the Cerebro Spinal system, as proved by Haighton, Cruickshanks, and Fontana; and lastly, they transmit sensations and excite the muscles. The former may be inferred from the pains occasionally felt in parts supplied by this system exclusively; and the latter is inferred from the experiments with Galvanism on the sympathetic Nerves, as will be detailed hereafter. So that whether we consider its structure,

functions, properties, or communications, we are in every point of view obliged to consider it a Nerve.

Now, the opinions concerning this Nerve may be reduced to the two following:—According to the first, the sympathetic Nerve takes its roots from the Cerebro-Spinal, and the Ganglions serve as barriers, reservoirs, &c., of the Nervous power. According to the second, it forms a perfectly distinct system, of which the Ganglions are centres, and its communications with the Cerebro-Spinal Nerves are not origins but anastamoses.

The first opinion to be noticed is, that the sympathetic takes its origin from the Cerebro-Spinal Nerves. Some have traced it from the fifth and sixth Cerebral Nerves. Its communication with the sixth nerve was discovered by Eustachius, and with the fifth by Willis and Lower. Others, as Johnstone, Lobstein, Le Gallois, and Philips, suppose it to take its roots from the Spinal Nerves, with the anterior branches of which it obviously communicates. If it be admitted to take its origin from this

system, it becomes a question, what is the use of the numerous Ganglia, by which it is interrupted? A variety of opinions on this subject may be seen in the note.* The most plausible amongst them, is, that of Johnstone. (See his Medical Essays.) He endeavoured to ascertain their use, by noting the peculiarities in the parts they supplied, the most obvious of which are, that these parts are not under the controul of the will, and that the sensations produced in them are less precise than in the parts

* Galen supposed that the Ganglions were simply the result of the union of the Nerves. Vicussens that they served to strengthen their subdivisions. Lancisi conceived them to be analogous to the Heart, having a muscular tunic, and serving to propel the animal spirits. Vic d'Azir believed them to be reservoirs for the animal spirits; and Meckel, Zinn, and Scarpa, that they were employed for the subdivision, re-union, and combination of the Nerves. The latter writer thinks they are of the same nature as the Plexuses, because nerves arrive to them from different places, unite, expand, and leave them in a greater number, and pursue different directions.

supplied by the Cerebro-Spinal Nerves. These considerations led him to conclude, that the use of the Ganglions was to intercept the progress of volition from the Brain, and of sensation towards it. His experiments in favour of this opinion, consisted in unsuccessful endeavours to stimulate the involuntary Muscles through the sympathetic Nerve, wherever a Ganglion intervened. Indeed, all the attempts of this kind were unsuccessful before discovery of Galvanism, even where no Ganglion intervened, and many have failed even when they employed this agent. Galvani, Volta, Valli, and Johnstone, were unable to stimulate the involuntary Muscles by the application of the Galvanic influence to the sympathetic filaments supplying them. Fowler failed in most instances, but on applying the Galvanic influence to the Cardiac Nerves, near the heart, and to the heart itself, he sometimes produced a slight effect. Humboldt, assisted by his brother, withdrew the heart from the chest of two rabbits and of a fox, and exposed one of the Cardiac Nerves. On ap-

plying the Galvanic influence to this, while the heart itself was carefully excluded, he found the contractions of this organ become distinctly stronger and more frequent. Bichat repeated this experiment, but without success. In order to oppose Johnstone's opinion, however, it is necessary either that the stimulus should be applied to the Ganglion itself; or that the Ganglions should be interposed between the stimulus and the heart. The experiment has succeeded in both ways. I have already spoken of Dr. Philips' experiment, in which he excited the Heart by stimulants applied to the Spinal Marrow; and Doctor Copland (the translator of Richerand's Physiology) found that when the influence of a battery of two hundred plates was directed on the semilunar Ganglion of a young cat, it evinced symptoms of pain and distress, and *several irregular contractions of the diaphragm supervened:* a few plates were sufficient to excite the voluntary Nerves. These experiments, however, only prove that the Ganglions are not insurmountable obstacles to the

cerebral influence, and this is admitted even by Johnstone himself. They do not refute his hypothesis, but they deprive it of a principal support.

The second opinion which I shall notice is that of Bichat. He supposes these Nerves to form a distinct system, of which the Ganglions are the centre, as the cerebro spinal mass is the centre of the Nerves of animal life. According to Bichat, all bodies in nature may be reduced to the class of organized or inorganized. Inorganized bodies, (as stones) increase in size by addition to their surfaces, they have no system of vessels internally for their support; they perform no functions, and they are not liable to decay. Organized bodies on the contrary, (as a man or a plant) increase by a growth or interstitial depoposition; this is effected by a certain apparatus or system of internal organs, the being provided with which constitutes them organized bodies. The actions of these organs are termed the functions of the body, such are Secretion, Absorption, &c. and all these functions taken together constitute life. Some

of these functions animals possesses in common with plants, as those above named, and they constitute the organic or vegetable life of the animal, over which Bichat supposes the Ganglionic system of Nerves to preside. Other functions however are peculiar to animals, as sense, voice, and locomotion; and these constitute animal life, over which the cerebro spinal nerves preside.

Many of Bichat's arguments in favor of this opinion have been since refuted, though the opinion itself has gained ground, Bichat seems principally to have directed his attention to proving from anatomical facts, that the Ganglionic Nerve was not derived from the fifth and sixth cerebral, inasmuch he oftentimes found it completely interrupted in its course, and as no connection could be traced between the lenticular spheno palatine and superior cervical Ganglions. These statements, however, were neither necessary to prove the Ganglions independent sources of nervous power, as will appear presently, nor were they correct in point of fact.

Lobstein observes, that during twenty-five years constant dissection, he never found any interruption in the sympathetic Nerve, which proves that it must be very unfrequent, and every student is at present aware of the communicating filaments between the above mentioned Ganglions.

Now if neither of these opinions are tenable, let us inquire what are the conclusions to which the experiments and reasonings on this subject would lead us. 1st. We have strong reason for supposing the Ganglions to be independent sources of Nervous power, since we find they are the only parts of the nervous system existing in some orders of animals, since they have been found performing their functions in the fœtus, where the Cerebro-Spinal mass was deficient; and since they are the first in order of developement. 2dly. Nothing can be clearer than the fact, that they have a connection with and are influenced by the Cerebro-Spinal system: this is rendered probable by their anastamosis with it, and is proved by the sensations transmitted from the

viscera to the Sensorium; by our passions stimulating the heart, and by our being able to excite conractions in the involuntary muscles through the Brain and Spinal Marrow. Dr. Philips has shewn that there are two distinct classes of functions belonging to the Nervous system, viz. Sensorial and Nervous. Now we find a portion of the Nervous mass is set apart for the *Nervous Functions of animal life,* which are distinguished from the Nervous functions of organic life, by their closer connection with the Sensorium, so that *the sensations* are perceived by the sentient principle, and *the irritation* of the Muscles to contract, is a consequence of volitions issuing from the same principle. It will therefore be expected that the organs (Medulla Oblongata, and Spinal Marrow) of these Nervous functions will be placed so as to communicate with the Sensorium, and accordingly we find them continuous, bound up together, and lodged in the same bony cavity. 2dly. Another part of the Nervous mass (the Ganglions) is set apart for *the Nervous*

functions of organic life, but here the case is altered: it is unfit they should, under ordinary circumstances, communicate with the Sensorium. For instance, what would become of life if the contraction of the Heart had been made an act of the will, or what advantage would arise from the contact of the various fluids being perceived? These (the ganglions) are accordingly distributed over the body at a certain distance from the Sensorium, or seat of perception and volition, but sufficiently near for the purpose of anastamosis.

Some of the most valuable discoveries connected with this subject are those of Le Gallois and Philips. It will, therefore, be of importance to shew, that the above views are not contradicted, but rather confirmed by the results of their experiments. 1st, They observe, in common with other physiologists, that the parts supplied by the ganglionic Nerves are, for the most part, involuntary. Johnstone attributed this to the obstruction given to volition in the Ganglions. But what is it that meets the obstruction?

Not the Nervous power, for this he admits to be necessary for the nutrition and functions of the viscera. His hypothesis, therefore, must imply, that both a Sensorial and a Nervous power are propagated along the Nerves, and that the Ganglions oppose the former, but not the latter. So that we find that when we come to any precision in terms, the hypothesis loses its apparent simplicity, and becomes exceedingly complicated and perfectly gratuitous, Volition is not a substance that travels along a Nerve in company with the Nervous power; but it is a stimulus that acts upon the source of the Nervous power itself. These objections do not lie against the view of this subject I have been explaining above. The Viscera receive their Nervous power from the Ganglions: their actions are not voluntary, nor their sensations perceived, simply because they have little connexion with the Sensorium,—but they have some, and this is sufficient to explain the influence of the passions and the perception of pain. 2dly, Dr. Philips found the parts supplied through the Gan-

glia depended not on a part, but on the whole of the Spinal Marrow. The reason of which is this, the Ganglions are sources of Nervous power; but they are bad conductors* of it. It is necessary, therefore

* Reil says, that the Ganglions are semi-conductors of the Nervous power; and in another place he observes, that "the more of them that intervene between the Brain and any organ, the more that organ is exempted from the influence of the Brain, and when a divided Nerve is reunited sensation is restored, but not motion." Rolando also considered the Ganglions as bad conductors of the Nervous power. His theory is very remarkable. He supposes the Cerebellum to be a Voltaic Pile, which generates a fluid analogious to, or identical with the Galvanic; that the Medulla oblongata is the Conductor in which the fluid is accumulated, and that through the Spine and Nerves it is transmitted to the Muscles for the purpose of motion. Sensations, on the other hand, he supposes to be produced by vibrations of the Nerves propagated from the circumference to the centre. When a Nerve is divided, sensation is consequently suspended, but returns gradually as the Nerve reunites; but motion does not return, because the newly formed substance, resembling in this respect a

that when the Nervous power is to be transmitted through Ganglions to any part, it should be propagated from a number of points, so as to compensate by the number of channels for the smallness and imperfection of each. And lastly, the same observation will explain another fact observed by Dr. Philips, viz. the necessity for stimulating an extensive surface of the Spinal Marrow in order to excite the heart.

I shall conclude this subject by a short account of the manner in which the Nervous system is developed.

The Sympathetic precedes the other parts of the Nervous system, and has been supposed by some

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Ganglion, is not a conductor of the Nervous or Galvanic power. The theory of the vibration of the Nerves has been considered already, and the objections to it stated ; but the opinion that the Ganglions are bad conductors of the Nervous power, is supported by respectable authority.

even to give origin to the Spinal Marrow. It appears, from the observations of Lobstein, that the Ganglions are very evident at the third month of fœtal existence; and, with the exception of the semilunar Ganglion, better developed, in proportion to the age, than after birth. The backward developement of the semilunar Ganglion has been supposed to imply a proportional languor in the functions of the Abdominal Viscera at the early periods of life; but this inference does not appear to be strengthened by comparing the developement of other organs with the Ganglia from which they receive their Nerves. Thus Bichat observed, that the Ganglions supplying the testicles (which are so backward in developement at the early periods of life) are as large, proportionably, as those supplying the stomach and liver. He also observes, that the Ganglions are most perfect from the thirtieth to the 40th year, but after this become smaller, dryer, and harder. The Nerves become greyer in advanced age, and are supposed to diminish in number. The

following are the appearances of this system, as examined by Lobstein at different periods of fœtal existence.

In an embryo of the fourteenth week, about three inches in length, the sympathetic Nerve was very evident. The superior Cervical Ganglion was two lines long, and one and a half thick. In the chest it was like a thick and red cord, because the Ganglia were near each other; but the Splanchnic Nerves were exceedingly delicate, and the semilunar Ganglion almost imperceptible.

At the third month the most of the Ganglia were very distinct; they were red, as in the adult, but harder, and better developed (in proportion to the age)—with the exception of the Semilunar, which are very slow in their developement.

In an embryo of five months (length six inches) the Sympathetic appeared an uninterrupted cord from the Cranium to the Pelvis. The great Splanchnic Nerve was very thin, and arose by three roots;

but the greatest diameter of the semilunar Ganglion did not exceed half a line.

In a fœtus at full time the superior Cervical Ganglion was about eight lines long, and a line and a half broad; it gave off four filaments for the branches of the external Carotid Artery, and a fifth for the Crico-thyroid Muscle. The thoracic Ganglions were well formed; each of them was about a line in breadth, except the first, which had five lines in breadth. They were red, and communicated almost all with the dorsal Nerves by two branches. The filaments connecting the Ganglions were about a third of a line broad, and were uninterrupted. The Lumbar Ganglions were very apparent; but the semilunar Ganglia were small when compared with the other Ganglions of this system.

The Spinal Marrow is the next part in the order of developement. At the fourth to the fifth week, the Spinal Marrow may be observed extending from the occiput to the lowest extremity of the spinal Canal; it is of a uniform thickness throughout, and about

half the size of the Medulla Oblongata. It appears to be formed of two longitudinal bands, one on either side; the anterior margin of these unite about the 5th week, and the spinal Marrow then represents a kind of gutter, open posteriorly throughout its whole length: the posterior margins do not completely unite till the end of the third month, and the union takes place from below upwards. When this is completed, the spinal Marrow represents a kind of Canal with a dilatation superiorly, which is to be the cavity of the 4th Ventricle. Its length, relatively to the spinal Canal, is gradually diminishing; at first it extends to the lower part of the spinal Canal; at seven weeks its lower extremity is opposite the lowest part of the Sacrum; at twelve weeks it is opposite the middle of the bone; at the fourth month opposite its base; at the fifth month it reaches to the last lumbar Vertebra; at the eighth month to the fourth Vertebra; and at the ninth month it is opposite the margin of the third. Serres supposes this change of position to depend upon a

true displacement of the Spinal Marrow by a movement of ascension; Tiedeman ascribes it to a more rapid increase in the Spinal Column, than in the Nervous Cord, which it protects. It may be observed here that the fœtus has a kind of tail or caudal prolongation in the earlier months, which disappears as the Spinal Marrow ascends, or as the Canda equina forms; and that cases have occurred in which the ascent of the Spinal Marrow has been arrested, and the fœtus consequently born with this tail. According as the limbs become developed, the Spinal Marrow loses its uniformity of size, and swells out at the parts supplying them. The division of the upper part or Medulla Oblongata into three bodies on each side, is seen distinctly at the fourth month; but the decussation of its anterior or pyramidal fibres may be observed as early as the fourth or fifth week.

The formation of the Cerebellum, Tubercula Quadrugemina and Cerebrum respectively, appears to depend on the production upwards of the Fasci-

culi composing the Medulla Oblongata. Thus the restiform bodies form the Cerebellum. The greater part of the Olivary bodies form the Tubercula quadrugemina, and the rest of them contribute with the Pyramidal bodies to form the Brain.

Let us first trace the formation of the Cerebellum: It occurs as follows:

Two Fasciculi from the posterior part of the Medulla Oblongata may be seen, at the end of the second month, to ascend and turn inwards against each other without uniting however; these are to be the restiform bodies, and the space they make the arch over, is to be the fourth Ventricle. At the third month they unite, and the Cerebellum is about three or four lines broad, concave within, and convex without. On the fourth month the rudiment of the ciliary body was observed under the restform body, and the fibres were seen descending, to form by their junction the future Pons. On the sixth month the lateral parts of the Cerebellum acquired a greater developement, and a little elevation above

the middle portion marked the appearance of the Vermiform process. At this time the division into lobes and lobules was evident, and the Ciliary body and Pons had increased in size. At the seventh month the Vermiform process was more sunk in relation to the hemispheres, and the parts composing its inferior region were more distinct. The inferior Velum and its lateral lobes could also be seen, as also the fibres proceeding from the Cerebellum to the Tubercula quadrugemina. At the eighth month the Hemispheres were well developed, the vermiform process more sunk, a soft substance (the Cortical substance) was deposited on the surface, and adhered to the Pia Mater, when that membrane was drawn off.

On the ninth month the transverse measurement of the Cerebellum was one inch four lines; its antero-posterior measurement was nine lines at the sides, but six and a half opposite the Vermiform process. The parts were well developed, and the laminæ had already appeared.

2dly.—The Tubercula Quadrugemina are formed by the middle fasciculi of the Medulla oblongata ascending, and then turning inwards to make an arch anterior to that formed by the restiform Bodies; when these unite, they form a kind of bag, the walls of which gradually thicken. This bag is the rudiment of mass of the tubercula quadrugemina, which at this time consequently encloses a kind of Ventricle. About the fourth month the hemispheres of the Brain extending backwards, cover their anterior part; and about the sixth month, cover the posterior part also. At the seventh month we perceive the nates and testes separated on the upper surface of the mass by a transverse, and a longitudinal fissure, and the ventricle in the interior is reduced to a small Canal. On the eighth month they increase in size, and on the ninth, they continue increasing, and the transverse exceeds the longitudinal diameter. The Pineal gland, which surmounts this mass, is not distinguishable till the fourth month, when it appears like a small flat

body, soft in its structure, and united by its delicate Pedicles to the margins of the optic Thalami. After this it continues gradually to increase, but does not at any time present concretions in its interior. The pedicles are formed before the body.

3dly. The Cerebrum appears to be formed by the anterior Fasciculi of the Medulla oblongata, and also by part of the middle Fasciculi: these may be seen ascending under the tubercula quadrugemina before the fourth month, as the Pons does not then exist. A little farther on they form the Crura Cerebri, which pass successively through the Optic Thalami, and the Corpora Striata. The former of these bodies are evidently enlargements of the Crura. Tiedeman observed the posterior Commissure uniting the Thalami at the end of the third month, but could not distinguish the Commissura Mollis till the ninth. As for the Corpora Striata, they are distinguished at the second month, and continue successively increasing till birth. Some of the fibres of the Crura pass beneath these bodies, others enter

them, and (having first sent very many fibres to meet similar fibres from the opposite side, and form the anterior Commissure) afterwards leave the Corpora striata, and, joining those that passed beneath, proceed to form the Hemispheres. If you cut into these bodies at the seventh month, they appear to form each a uniform reddish vascular mass, so that at this time their name is not applicable. At this period also (the seventh month) the Tænia Semicircularis makes its first appearance in the form of a soft vascular mass between the Corpora Striata and Thalami.

After passing through these two bodies the fibres of the Crura expand to form the hemispheres. These hemispheres, as seen at the second month, appear to be merely Membranes covering the rudiments of the Corpora striata, and covered by the Pia Mater. Their developement occurs from before backwards. At the end of the third month they cover the Thalami, and at the end of the fourth cover also the anterior tubercula quadrugemina: at

the sixth they cover these tubercules and part of the Cerebellum; at the seventh month they go back beyond the Cerebellum. The rudiments of the Convolutions now appear; the fissure of Sylvius becomes deep; and finally, at the ninth month, the hemispheres appear as in the adult.

The Corpus Callosum, which is seen uniting the hemispheres in the adult, first appears towards the latter end of the third fœtal month. It is formed by a production of the fibres of the Crura Cerebri. It is first observed in front, and its position is perpendicular; but proceeding in its developement from before backwards, it assumes the horizontal direction about the sixth month. The fibres that formed the hemispheres having arrived posteriorly, form the Cornu Ammonis or Hippocampus Major, by uniting with the posterior pillars of the Fornix, which is the next part to be described.

At the end of the third month *the Fornix* does not exist in the Brain of the fœtus, but towards the latter end of this period we observed two riband-

like bands, arising from the Optic Thalami; these descend into the Corpora mamillaria, and then ascend, being reflected on themselves: they constitute the anterior pillars of the Fornix. On the fourth month, these pillars are slightly connected, and then they proceed backwards over the anterior part of the third Ventricle; they again separate into two bands, each of which proceeds outwards and backwards round the Optic Thalami, forming the posterior pillars of the Fornix. While passing under the Corpus Callosum, and at about the fifth month, the Fornix sends upwards to the former two thin plates that form the *septum lucidum,* and enclose the fifth Ventricle. On the seventh month, the posterior pillars are united by transverse bands that form the Lyra, and then they may be traced on till they plunge into the hemispheres.

I have observed that the great Hippocampus, (which is one of the latest parts developed in the Brain of the Fœtus) results from the union of the posterior pillars of the Fornix with the fibres de-

scending from the roof of the Ventricles. At the fifth, sixth, and seventh month, it appears as a fold of Cerebral matter in the inferior Cornu of the lateral Ventricle; and it is not until the ninth month we can perceive its enlarged extremity and digital processes. The lesser Hippocampus also appears very late: its progress is slow, and it is sometimes deficient in the adult.

The Ventricles are not developed in the order their names would lead you to suppose. The fourth Ventricle is the first formed, and then follow in succession the middle, lateral and fifth Ventricle.—I have already observed that the fourth Ventricle was at the first merely the superior part of the Canal of the Spinal Marrow, which was afterwards gradually covered in, as the Cerebellum became developed. The Ganglion of the Acoustic Nerve (or Ruban Gris), is observable at the bottom of this cavity at about the fourth or fifth month. In the latter months the fourth Ventricle increases in extent, but rather diminishes in relation to the volume

of the Brain and Cerebellum. Neither Tiedeman nor the Wenzels, could discover in the fœtus the white striæ leading from the calamus Scriptorius, and supposed to be the origins of the auditory Nerves.

The only other opinion I shall notice is that of Serres. He maintains that the Spinal Marrow, Cerebellum, and Cerebrum, are formed respectively by the Intercostal, Vertebral and carotid Arteries. He supposes that the Arteries of the Spinal Marrow are the first formed, and therefore that the rudiments of this Organ are the first developed. Then follow the Crura Cerebri and Tubercula Quadrugemina, and that the Cerebellum is the last Organ apparent, because the Vertebral Artery arrives last into the Cranium. So that he supposes three centres of formation, and therefore differs from Malpighi and Gall, who supposed the Brain and Cerebellum to radiate *from* the Spinal Marrow; and also from Willis, who supposed it to be formed from the circumference *towards* the Spinal Marrow.

The direction of the Carotid and Vertebral Arteries within the Cranium will explain, according to Serres, why the Brain is developed from before backwards, and the Cerebellum from behind forwards. In confirmation of his opinion he observes, that the Sympathetic Nerve is found to diminish in a direct ratio with the decrease of the Sanguineous system;—that in animals, the size of the Caudal prolongation is proportioned to the size of the middle sacral Artery;—that from the volume of the Arteries in the extremities, we can always infer the volume of the Nerves;—and that the Ophthalmic Artery supplying an organ of the face, is not proportioned in size to the internal Carotid that gives it off, but to the external Carotid Artery. Serres's opinion is opposed by Olivier, principally from his having observed that the hemispheres of the Brain, and other parts of the Nervous Mass, were deficient, or badly developed, where the Arteries that should supply them were large.

APPENDIX.

The Reader is requested to make, with his Pen, an Asterisk, or other mark, at each of the Pages to which these Notes belong.

P. 11.

Sir E. Home described a case of *unfolding of the Convolutions* of the Brain by means of the Water of Hydrocephalus, before the publication of Gall and Spurzheim. See Phil. Trans. 1814. P. 474.

P. 19.

Various uses have been assigned to the Ventricles of the Brain; some suppose they serve to admit the Pia Mater for the nourishment of its interior; others, that they are intended to interrupt the fibres of the Brain, lest their length should render them too weak. Sir Everard Home supposes they serve to equalize pressure. (*See his Comparative Anatomy, Vol.* 3,

page 41.) An opinion resembling this is also maintained by Magendie.

P. 36.

Gall regards the Pineal Gland as a Ganglion giving origin to medullary Cords. Tiedeman considers it as a Commissure uniting the Thalami, and increased by cineritious substance.

P. 50.

In classing the Lobes and Lobules of the Cerebellum, I have followed the arrangement of Reill, who has made this part of the Encephalon his particular study.

P. 67.

Haller is generally supposed to have overrated the quantity of Blood sent to the Brain. Monro's calculation is less by one half. Magendie says, that an eighth part of the Blood sent from the Heart goes to this organ.

P. 68.

Lymphatics have not been discovered in the Brain ; but Sir E. Home describes small Veins, provided with Valves, which accompany the minute Arteries ; these he supposes to perform the office of Absorbents. He considers the superior Longitudinal Sinus rather as a reservoir for their contents than a true Vein,

and in confirmation of this he observes, that its Blood is very black, and peculiar in its appearance. See his Comparative Anatomy. Vol. 3. page 41.

P. 88.

Mr. Bell does not expressly say that the posterior roots of the fifth Nerves can be traced to the Corpora Restiformia, but it is implied in his Theory. He says they come from the Peduncles of the Cerebellum. Now the Crura Cerebelli are the *lateral Peduncles*, and the Restiform Bodies are the *inferior Peduncles* of the Cerebellum.

P. 100.

Since writing the Note in page 100, I have met a passage in Spurzehim's Work, showing that he considers the Vela as a *Commissure*, and therefore uses this term in a more extended sense than Dr. Gordon. The following are his words:—" Let us always carefully distinguish that which composes the junction or *Commissure of one side with corresponding parts of the opposite* side from that which *unites parts on the same side*, as for instance, the nervous filaments which are prolonged from the superior part of the posterior pyramids to the Cerebellum, and those which proceed from the Cerebellum to the Testes. In page 260, *Vol.* 1, *quarto Edition*, he observes, " One has

very improperly given to these fibrous expansions the names of the superior and inferior Vela, or rather of Processus ad Medullam oblongatam, and Processus Cerebelli ad Testes." What many others understand by the Inferior Velum I know not, but I am very certain that the Inferior Velum of Reil, (described at page 114) is as different a thing as possible from either the Processus ad Medullam Oblongatam or Processus ad Testes.

P. 126.

I should have observed here, that the sacral Nerves form their Ganglions within the Spinal Canal, and therefore before they reach the Spinal Foramina.

P. 134—135.

Magendie supposes that the Spinal Marrow is moreover protected by being immersed, during life, in a Serous Fluid which fills, and strongly distends the Arachnoid Sac of this region. If the Sac be punctured the fluid spouts to many inches in heighth.

P. 185.

Sœmmering distinguishes *four* substances in the Brain, viz. white, brown, yellow, and black. The yellow is found most abundant in the posterior Lobe of the Cerebrum, and the black may be seen in the interior of the Crus Cerebri.

P. 195.

Dr. Phillips supposes that Perception may occur without consciousness. I have every where employed the term Perception, to express " Sensation accompanied with consciousness." It is difficult to conceive how an act of the Will can be the consequence of a Perception without consciousness having occurred. I am not sure that I understand Dr. Phillips' reasoning, but I think he infers the occurrence of Perception from the voluntary act (Respiration) that follows it ; and supposes that consciousness does not accompany it—only because the patient has not the remembrance of having been conscious during the apoplectic fit.

P. 198.

I have defined Irritability to be a property of the Muscular Fibre, by which it is capable of being excited to contraction. I should have also given a name to that property of the Nervous System by which it receives impressions—some of which are transmitted towards the Muscles to produce Contraction, and others towards the Cerebro-Spinal Mass, to produce Sensation. The best name I know for this property is *Impressibility*, a term first employed in the E. Med. Surgic. Journal for 1814. In page 209 of this Work, I have quoted Dr. Phillips using the

word *Excitability*, in a sense that includes both the *Irritability* of the Muscles and the *Impressibility* of the Nerves. See p. 209.

P. 202, 205.

Besides the cases mentioned in the text of motion remaining in the lower extremities after complete division of the Spinal Marrow, many others have been observed of a similar nature:—one by Mr. Wallace of Dublin, and another, I believe, by Mr. Bell, so that the fact is ascertained beyond all doubt. When the division of the Spinal Marrow occurs above the giving off of the Phrenic Nerve, death happens inevitably: the reason of this difference I am now to assign. *The vegetable life* of any part of the body, as an extremity, seems to depend solely upon the portion of the Cerebro Spinal Mass, from which it receives its Nerves; and in some cases the Nerves themselves seem perfectly adequate to preserve it. *The Animal Life* of a part (evinced by its possessing *voluntary* motion and feeling), depends on a principle propagated from the Brain through the Spinal Marrow and Nerves. Now the effects of dividing of the Spinal Marrow at different parts must be evident. If divided in the lumbar Region, the parts below are reduced to a state of vegetable existence, in which they will possess the Functions of secretion, *Motion*, &c., *but not voluntary Motion*—at least until

a reunion occurs. The division of it in the Dorsal Region not only reduces the parts below to a vegetable existence, but more-over deprives some of the Intercostals of the influence of the Will, and, by embarrassing Respiration, diminishes the chance of recovery. Lastly, if divided above the giving off of the Phrenic, Respiration, which I believe with Dr. Philips to be a purely voluntary act, must cease, and the Blood becomes unfit for the support of the various organs, including the organs of the Sensorial Functions, which therefore cease.

P. 224.

Malacarne found only 324 plates in the Cerebellum of a mad person, while in other persons he found more than 800.

P. 224.

Willis appears to have anticipated Magendie's opinion concerning the Convolutions; he expressly calls them a storehouse of images. And Mery has anticipated him in the opinion, that the fifth, and not the first Nerve, was the Nerve of Smell.—(Mery: Progrès de la Medicine.)

P. 225.

The following Table represents the proportion between the Brain and Cerebellum at different ages, according to the Wenzells.

Age.	Weight of whole Brain.	Weight of Cerebrum.	Weight of Cerebellum.	Ratio of Cerebrum to Cerebellum.
	Grains.	Grains.	Grains.	
Five Months after Conception.	720	683	37	$18\frac{17}{37} : 1$
At Birth.	6,150	5,700	450	$12\frac{2}{3} : 1$
3rd. Year	15,240	13,330	1,860	$7\frac{6}{31} : 1$
5th.	20,250	17,760	2,490	$7\frac{11}{83} : 1$
25th.	22,200	19,500	2,760	$7\frac{6}{27} : 1$
46th.	20,490	18,060	2,430	$7\frac{35}{81} : 1$
81st.	23,970	21,210	2,750	$7\frac{63}{92} : 1$

The weight of the Brain is suppposed to be about $\frac{1}{40}$th of that of the whole body. *Haller*. x. 5. 20. The weight of the Spinal Marrow compared with that of the Brain is at birth as 1 to 40: and in the adult as 1 to from 19 to 25. *Cloquet*, p. 538. The Mesocephale weighs about a 60th of the Brain and Spinal Marrow together.

P. 230.

Magendie's opinion may here be explained more fully: he observes that as the Pons is united to the Cerebellum by the Crura Cerebelli, these four parts together form a kind of circle ; and if either side of that circle be divided, whether in the Cerebellum, Crus, or Pons, the animal rolls towards the injured side incessantly. From this he concludes that there exist two forces in this Region which balance each other, and which tend across the circle formed by the Pons Varoli and the Cerebellum. Beside these, he has observed impulses in the directions forwards and backwards. His proofs are these : he has found that on abstraction of *both* the Corpora Striata (not of its brown part, for this produces no effect), in Man and Mammalia, the animal seems impelled *forwards* by an irresistable power. If, on the contrary, the Cerebellum or Medulla Oblongata suffers a Lesion, the animal performs a *retrograde* motion. From this he infers that there exists in the Cerebellum or Medulla Oblongata an impelling power, which tends to cause animals to move forwards, and that this is balanced by an opposite power residing in the Corpora Striata. It is remarkable that these motions do not produce fatigue ; he has observed them last in one case almost incessantly for nearly eight days. There is still another order of Impulses remaining to be described. He exposed the fourth Ven-

tricle of a Rabbit of three or four months, and " raising the Cerebellum, made a perpendicular section to the surface of the Ventricle, and to from one one-fourth, to one four-fifths of a line (.11811 to .15748 of an inch English) on the outside of the median Plane." The consequence was a movement in a circle from right to left, resembling that of the *Manege*, the animal turned towards the divided side. The section was made " so as to affect the portion of that Medulla which approaches the interior of the anterior Pyramid. (*See Milligan's Magendie, p.* 193.) Observe that the Rotatory motion in the first order of Impulses was round the long axis of the body, and in this round its antero posterior diameter. Mayo refers these effects to a kind of Vertigo, in consequence of which the animal imagines itself hurried in a direction opposite to that in which it moves.

P. 232.

It has been generally believed that the Soporific effects produced by Vertical pressure on the Brain and Cerebellum, are the consequence of the pressure consequently made on the Medulla Oblongata, since *lateral* pressure of the former parts is not followed by similar effects.

P. 234.

It appears from the following Extract, that Haller was aware

that the anterior and posterior roots of the Spinal Nerves had different functions, and even knew that the anterior were distributed to the Organs of Motion exclusively; but he was not acquainted with the functions—either of the Posterior Roots, or of the System of respiratory Nerves.

"Omnes nempe Nervi Spinales, vix uno altero ve in collo excepto, egressi de vertebris posteriorem et anteriorem truncum habent. *Ille musculis unicè datus est. Iste* producit radicem nerveam, quæ juncta sodalibus, et addito exiguo surculo, qui a sexto nervo cerebri advenit, unum principem corporis humani nervum efficit, qui, cum fere omnibus aliis Nervis totius corporis conjunctus, ad cor et abdominis vicera omnia ramos nerveos educit." Haller. lin. prim. sect. 376. Gott. 1751.

P. 237.

The non ganglionic portion of the fifth Nerve, goes almost exclusively to form the Buccal and deep Temporal Nerves.

P. 253.

The results of *Magendie's* experiments differ very much from those related in the text. He divided, in dogs, the eighth Nerve of one side, and three months afterwards the eighth Nerve of the opposite side; the animals died three or four days after the last division. On dissection he found the lung to which the first

divided Nerve belonged, so morbidly changed, as to be incapable of respiration. How did the section of the second Nerve (he inquires), produce death? In the fourth number of the London Medical Gazette you will find an abstract of *M. Prevost's* experiments. The following are the conclusions he draws from them :—that when a Nerve is divided, it is not sufficient for the restoration of its function that the two divided portions be united by the interposition of whitish cellular Membrane.—It is necessary that nervous fibres be sent through this from the upper to the lower portion of the Nerve.—This prolongation appeared to take place only after some time. The prolonged fibres had not acquired a regular juxtaposition as in a continuous Nerve, but were separated as if they had made their way, with difficulty, through the interposed substance. *Flourens* has lately endeavoured to determine the result of the union of *different Nerves* crosswise. His experiment consisted in dividing two adjacent Nerves, and uniting the upper portion of one to the lower portion of the other. Union occurred in every instance, and the function of the Nerve returned in some.

P. 259.

The Nerves employed in Sensation, were supposed by Diemerbroeck and others, to have Valves in their interior.

P. 272.

In addition to the authors mentioned in the text, I may add that Wutzer and Beclard have seen contractions of the Muscles produced by a stimulant (the Galvanic power), applied to the Sympathetic Nerve.

P. 284.

The Cerebro Spinal Nerves should have been noticed here, as they precede the Spinal Marrow in developement. They are not productions from the Brain or Spinal Marrow, but are separate and sufficiently distinct, while the Brain has still the form of a Vesicle ; after this they proceed towards the Cerebro Spinal Mass, and unite with it : the Cervical Nerves join it the latest. Modern researches on the Nervous System lead to the conclusion, that the changes observed in the human Brain during the successive periods of fœtal life, correspond with the changes observed in the Brains of adult animals, as traced through the successive links from the zoophyte up to man. Thus the ganglionic System of Nerves is the first formed in man, and accordingly we find, that this System *alone* constitutes the nervous apparatus of the lower order of animals ; while the Cerebellum, which is the last part developed in the human Brain, is only found in those animals that are high up in the scale.

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ERRATA.

Page 110, line 10, for *Crus Cerebri* read Tractus Opticus.
—— 70, —— 7, after *Branches* insert a colon.

END OF VOL. I.